A. R. Collins

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, CHIEF

FOURTH SERIES – BULLETIN 32

FAUNA OF THE SILICA SHALE OF LUCAS COUNTY

by

Grace Anne Stewart

COLUMBUS 1927

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, CHIEF

FOURTH SERIES – BULLETIN 32

FAUNA OF THE SILICA SHALE OF LUCAS COUNTY

by

Grace Anne Stewart

COLUMBUS 1927

Reprinted 1948 without revision
Reprinted 1966 without revision

Price $1.00 plus tax

Published by the authority of the Legislature of Ohio, under the Supervision of the State Geologist.

Columbus Blank Book Company
Columbus, Ohio 43207
1966
Bound by the State of Ohio

TABLE OF CONTENTS

ILLUSTRATIONS

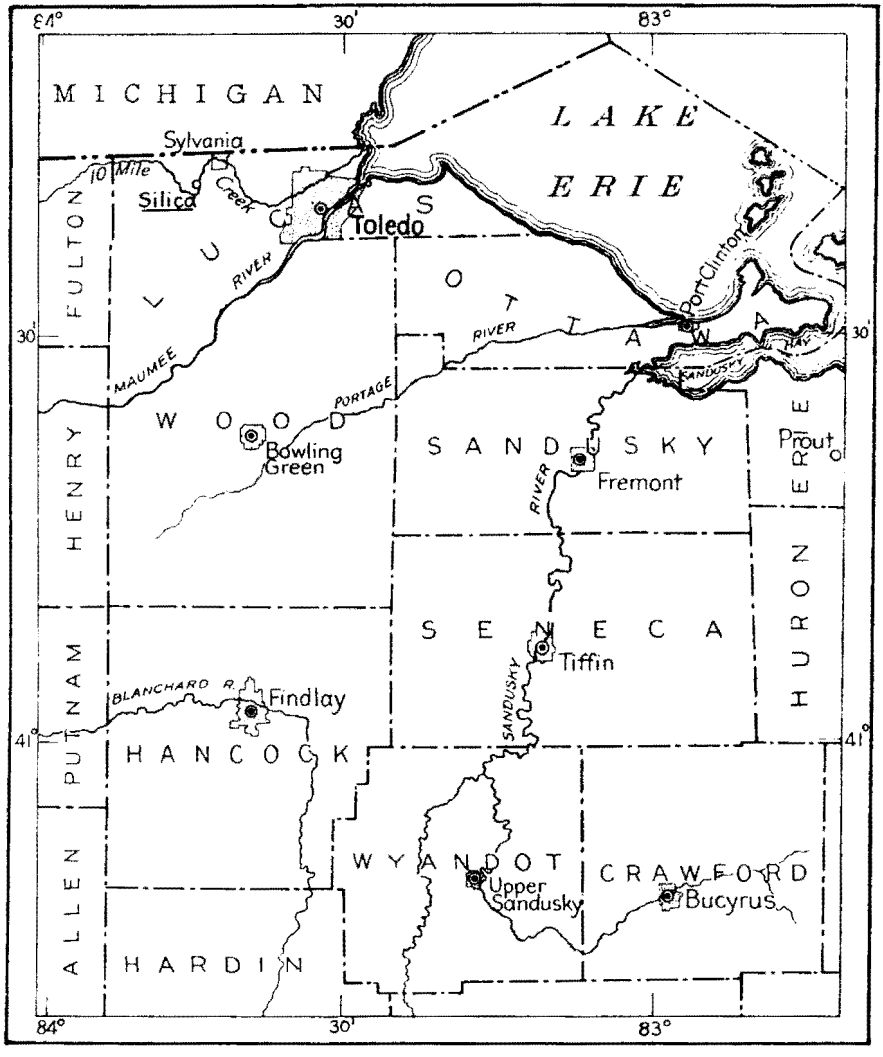
PLATES

MAP

Blank Page

INTRODUCTION

Within the last few years a certain unit of shale in the Devonian rocks, exposed in the quarry of the Sandusky Cement Company near Silica, Lucas County, has yielded a fauna more typically Hamilton



Map of a part of northwest Ohio showing the location of Silica

than any previously found in Ohio. To this unit the name Silica shale is given from the near-by village of Silica. This paper comprises a study of the fauna from this horizon. Collecting from the shale has

been carried on at intervals for the past four or five years, and the manuscript for the most part was prepared during the summer of 1926. Sixty-two species thus far have been described from our collections, eleven of which are either new species or new varieties.

In addition to the material collected by the writer and her associates at Ohio State University, excellent specimens of trilobites and crinoids have been presented by Mr. C. D. Miller of Sylvania, who has made a remarkable collection of trilobites from the shale. Pleasure is had in acknowledging with thanks this assistance from Mr. Miller and in expressing appreciation of his great interest in collecting from the Silica shale. It is likewise a pleasure to acknowledge appreciation to Professor J. A. Bownocker, State Geologist, who has made it possible for this study to be carried on, and who has shown a kindly and helpful interest in its progress. To Professor J. E. Carman, Department of Geology, Ohio State University, the writer is indebted for valuable aid in identification of certain species, and for reading and criticising the descriptions. Thanks are extended to Miss Winifred Goldring of the State Museum, Albany, New York, for studying the crinoid collection, and to Professor G. M. Ehlers of the Department of Geology, University of Michigan, who supplied fossils from the Traverse formation of Michigan for study purposes.

STRATIGRAPHY

The Middle Devonian formations outcrop in belts throughout central and northwest Ohio. In the central part a three-fold division has long been recognized, but in northwest Ohio Stauffer made only two distinct divisions. The correlation of the northwest divisions with those in the central region, and with the Middle Devonian formations in New York State is as follows:[1]

Northwest Ohio	*Central Ohio*	*New York*
Traverse	Olentangy formation	Hamilton beds
	Delaware limestone	Marcellus shale
Columbus limestone	Columbus limestone	Onondaga limestone

The Columbus limestone of northwest Ohio lithologically and faunally is similar to that of the central part of the State, although generally it does not attain so great a thickness. For the upper part of the Middle Devonian in northwest Ohio Stauffer has introduced the Michigan term, Traverse, for the rocks between the Columbus limestone and the Ohio shale, considering them to be the southward extension of the Traverse formation of Michigan. No correlation with the Michigan members was attempted.

The Traverse formation as defined in northwest Ohio is considered to be approximately the time equivalent of the Delaware limestone and Olentangy shale of the central part of the State, and 53 per cent of the Traverse fossils have been identified with Delaware and Olentangy species. The Olentangy formation has been recognized as the only true representative of the Hamilton in central Ohio, apart from the Prout limestone, which lies above the Olentangy shale in the Sandusky region.

The Silica shale of Hamilton age

The Traverse formation of northwest Ohio is dominantly Hamilton in its faunal content, and perhaps no one bed carries such a fine assemblage of Hamilton fossils as does the Silica shale bed which in recent years has been uncovered in a quarry of the Sandusky Cement Company about 8 miles west of Toledo and a half-mile north of the village, Silica.

The shale is bluish-gray in color, soft and highly calcareous, and disintegrates very rapidly on exposure. It contains much iron pyrite, or more correctly speaking marcasite, which is in the form of concre-

[1]Stauffer, C. R., Geol. Surv. Ohio, Bull. 10, 1909, p. 156.

tions or as a replacement of the shell material in the fossils. The Silica shale overlies a heavy, blue limestone layer which is also rich in fossils. The line of separation between the limestone and the shale is not clear cut lithologically, there being a transition through shaly limestone to the shale above. In the upper part of this transitional layer fossils occur in abundance. Some of the characteristic forms are *Spirifer mucronatus var. prolificum, Stropheodonta demissa, Chonetes coronatus, Chonetes fragilis, Rhipidomella vanuxemi.*

A thick-bedded, bluish-gray limestone layer overlies the Silica shale, and about 3 feet of it is exposed on the west wall of the quarry near the north end. The contact between the shale and this overlying limestone layer is well defined, and is marked by masses of branching sea weed wherever the contact was observed. The upper surface of the limestone reveals excellent glacial striae which were seen on loose blocks of the limestone lying about on the quarry floor. On the east side of the quarry at the north end drift overlies the Silica shale, which probably forms the bedrock for most of the width of the quarry, a distance of two or three hundred yards at this place.

The rocks in this region have a general westward dip of about 7 degrees.

An approximate section in the quarry follows:

Traverse formation	Feet
Blue limestone	3±
Silica shale	10±
Shaly limestone	4±
Blue limestone	6±
Columbus limestone	

Since the section was taken quarrying operations have been suspended in the north part of the quarry where the best section of the Silica shale was exposed, and there has been considerable slumping of the debris from above, so that now only two or three feet can be seen. In the west wall of an adjoining quarry about one-half mile south, small patches of the Silica shale are exposed at intervals. Loose material had fallen and covered up most of the exposures at the time of the writer's visit which prohibited extensive collecting, but a few of the characteristic fossils were picked up.

The Silica shale evidently thickens rapidly westward. Two test holes drilled by the company, one near the north end and one near the south end of this adjoining quarry, and about 50 feet west of the present west wall of the quarry, show 17 and 15 feet of shale respectively. These figures, however, may include the shaly limestone layer of the first quarry which underlies the shale.

So far as known the only exposures of the Silica shale are those which have been artificially produced in the quarries, unless it has been recognized by Stauffer[1] in Zone 7 of his Tenmile Creek section, about one and one-half miles south of the quarries. This zone is in the main a covered interval, but in part is known to consist of blue shale as shown by the material dredged from the bottom of the creek, and it includes the contact of the Columbus and Traverse formations. This blue shale horizon may correspond to the Silica shale farther north.

The fauna, Hamilton

A comparison of the Silica shale both lithologically and faunally with the Olentangy formation in the Sandusky region east of the anticline is of interest. The Olentangy formation on the whole is poor in fossils, but in the Sandusky region becomes very fossiliferous, and a number of these species, as shown by the faunal table, are also present in the Silica shale. Generally speaking, though, the most abundant and characteristic Silica shale species are either absent or extremely rare in the Olentangy formation. For example, such forms as *Atrypa reticularis*, *Stropheodonta demissa*, and *Chonetes coronatus* are among the most abundant species of the Silica shale, but in the Olentangy shale are exceedingly rare. On the other hand *Ceratopora rugosa*, *Aulopora serpens*, *Leiorhynchus kelloggi*, and *Chonetes deflectus*, occur in profusion in the latter formation, but are either absent or of rare occurrence in the former. Hence, although there are many species common to these two faunas, their main elements are by no means identical.

It is probable that the Silica shale is the time equivalent of the Prout limestone which occupies the same stratigraphical position in Erie County in the north central part of the State, but that unit does not carry such an abundant fauna as the Silica shale. A satisfactory comparison of the faunal relationships of these two units can not be made at this time since only a small collection of Prout fossils is available for study. Species common to both are *Zaphrentis prolifica*, *Heliophyllum halli*, *Atrypa reticularis*, *Stropheodonta demissa*, and *Stropheodonta (Leptostrophia) perplana*. Furthermore, the resemblance of the Silica shale fauna is very close to that of the Widder beds of Ontario with the basal portion of which the Prout limestone has been correlated.

There is no doubt that the Silica shale is of Hamilton age, but it is not possible at present to correlate it with any particular horizon of the Hamilton in New York or Ontario.

---

[1]Stauffer, C. R., Geol. Surv. Ohio, Bull. 10, 1909, p. 145.

DISCUSSION OF FAUNA

The fossils of the Silica shale weather out easily from the matrix, and the quarry floor has afforded an exceedingly easy and profitable place for collecting. The fossils are generally excellently preserved, and show in detail the fine surface sculpture of the shell which is of marked value in identification. The iron oxide, marcasite, commonly replaces the shell material, and has been referred to as pyrite in various places in this paper.

The predominance of Hamilton species is noteworthy and the correlation of the assemblage with Hamilton faunas elsewhere is shown in the faunal table. The mingling of Onondagan and Hamilton forms is evident as 16 species of the Silica shale fossils are also present in the Columbus limestone. This is not an unusual condition, however, since the Hamilton is primarily a derivative from Onondagan faunas. Of the 62 species so far recognized, 11 have been described as new; 43, or about 69 per cent, are common New York Hamilton species; while 35, or approximately 50 per cent, are present in the Widder beds of Ontario which are also Hamilton in age. The resemblance to the Delaware and Olentangy faunas of central Ohio is not so striking since only 19 of the Silica shale fossils are common to the former and 15 to the latter. However, neither of these formations carries such an abundance of species as does the Hamilton in either New York or Ontario, so it is not surprising that more species are not found in common with the Silica shale. Twenty-three species occur in other units of the Traverse in northwest Ohio.

PLANTS

At the contact of the shale with the overlying limestone there seems to be everywhere present in the region of the quarry large masses of branching seaweed. These are the only plant remains that have been recognized, and since it is not the purpose of the writer to discuss plants in this study, determination has not been attempted.

CORALS

The corals form a minor element in the fauna and are few both in species and individuals. They are in fact extremely scarce when compared with their abundance in other parts of the Traverse of this region and in the Hamilton faunas of Ontario where 60 or more species have been recognized. When, however, we take into consideration the small portion of the Hamilton represented by the shale, and that altogether

only 62 species of invertebrates have been identified, the paucity of the corals when considered relatively is not so marked. The two most characteristic and abundantly represented species are *Cystiphyllum vesiculosum* and *Heliophyllum halli*. Only two of the species are present in the Olentangy shale, and three in the Delaware limestone. These are *Aulopora serpens*, *Cystiphyllum vesiculosum*, and *Heliophyllum halli*. *Zaphrentis simplex* has been reported only from the Traverse in Ohio and so apparently is absent from the central part of the State.

VERMES

Only two worms belonging to the genus *Spirorbis* have been identified; one of which is a new species, and the other is new to the Ohio Devonian, but occurs in the Widder beds of Ontario. Both forms are cemented to brachiopod and pelecypod shells.

CRINOIDS

One species only of crinoid has been definitely identified but it is represented by a number of fine specimens. It is of peculiar interest because neither genus nor species has been reported from Ohio before; and because many of the specimens have the tegmen unusually well preserved, and have in addition retained their fine surface tubercles. This species has been reported so far only in the Hamilton of Ontario so that its recognition in Ohio strata extends the geographical range considerably westward. An abundance of crinoid plates and stems have been noticed but these are of no diagnostic value.

BRYOZOA

In abundance of species and individuals the bryozoa are next in importance to the brachiopods. They are for the most part restricted to the lower layers in the shale and occur in masses almost to the exclusion of everything else. Of the 16 species that have been recognized 3 are described as new. Liability to make mistakes in their determination is great because most specimens are replaced by iron oxide which is opaque and prevents the recognition of internal characters in thin sections, so that the species listed may not adequately represent the total number in the shale. Ten of the forms identified are in the Hamilton of New York. *Cystodictya incisurata* is the most characteristic and by far the most abundant bryozoa present. The genus *Hederella* is particularly conspicuous because of the spreading and branching fronds which are generally attached to Spirifer shells. *Hederella canadensis* is the most abundant of the three species represented. Other characteristic Hamilton bryozoa present are *Reptaria*

stolonifera, Streblotrypa hamiltonensis, Botryllopora socialis, Acanthoclema sulcatum.

BRACHIOPODS

The preponderance of brachiopods both in point of species and in individuals is the outstanding feature of the fauna. They are represented by at least 21 species and varieties, 4 of which are described as new. The splendid preservation of the surface markings, particularly in the Spirifer group, is of special interest and furnishes an extremely helpful means of identification. The species are by no means all abundantly represented and in some cases only one or two specimens of a species have been found. Some of the abundant forms are *Atrypa reticularis, Chonetes coronatus, Chonetes fragilis, Rhipidomella vanuxemi, Spirifer audaculus, Spirifer bownockeri, Spirifer euryteines, Spirifer mucronatus var. prolificum,* and *Stropheodonta demissa.*

Of the Spirifers, the species *Spirifer bownockeri* is particularly interesting because of the distinctness of the surface sculpture and the uniformly large size attained by full-grown examples. *Spirifer mucronatus var. prolificum* is the most abundant of all the brachiopods, and in places makes up most of the rock. *Spirifer mucronatus* occurs only in rocks of Hamilton age in Ohio, and in central Ohio is rare, being present only at the top of the Olentangy shale, but it is much more abundant in the Traverse beds of the Northwest. A new varietal name has been given its representative in the Silica shale because of some evident variations from the typical species. One would expect to find in rocks of Hamilton age some of the more ornate species of the genus *Atrypa,* but *Atrypa reticularis* is the only representative and is present in abundance, some specimens being conspicuously large. *Chonetes coronatus* also attains remarkably large dimensions, and in contrast to its rarity in beds of Hamilton age east of the anticline occurs in profusion in the Silica shale. *Rhipidomella vanuxemi* and *Stropheodonta demissa* are also large, and many good specimens of both species have been found.

PELECYPODS

This class of Molluscs forms an insignificant element of the fauna and is neither abundant in species nor in individuals. *Pterinea flabellum* is of most frequent occurrence and is commonly in the form of internal molds which have the coarser external sculpture impressed on them. Of the five species of pelecypods that have been recognized this is the only one that has been reported in the Widder beds of Ontario. All of them occur in the New York Hamilton.

GASTROPODS

Gastropods are not common in the shale and are represented by

2 genera and 4 species. Three of the species belong to the genus *Platyceras*, and are particularly difficult to define because of the extreme irregularities of the shell where it is attached to other organisms. *Platyceras bucculentum* is usually found attached to the tegmen of *Arthracantha carpenteri*.

Styliolina fissurella and *Tentaculites bellulus* (?) are rare, the latter represented by one or two indefinite specimens.

CEPHALOPODS

Fossils of this group are rare and the few fragments found do not admit of positive specific determination.

TRILOBITES

The widespread *Phacops rana* is here represented by a new variety to which the varietal name of *milleri* has been given. The excellence of some specimens is remarkable, but as a rule good specimens are difficult to find, and the most ardent and persistent collector is usually rewarded with only an occasional perfect one. *Phacops rana* is present in the Olentangy shale and Delaware limestone east of the anticline, and in the Traverse formation west of the anticline.

OSTRACODS

One species only has been collected which is described as new. It has been referred provisionally to the genus *Cytherella*, a genus not previously recognized in Ohio Devonian strata. The separate valves commonly occur and the surface markings on them are beautifully preserved.

TABLE SHOWING CORRELATION OF SILICA SHALE FAUNA WITH SOME MIDDLE DEVONIAN FAUNAS IN OHIO AND ELSEWHERE

List of fossils from the Silica shale	Ohio				Ontario			Maryland	New York
					Hamilton formation				
	Traverse	Olentangy	Delaware	Columbus	Widder	Olentangy	Alpena	Hamilton	Hamilton
Plants									
Plant remains									
Corals									
Aulopora serpens Goldfuss (?)	x	x	x	...	x	...	...	...	x
Ceratopora flabellata Greene									
Ceratopora jacksoni Grabau	...	...	...	...	x	...	...	...	x
Cystiphyllum vesiculosum Goldfuss	x	...	x	x	x	...	x	x	x
Heliophyllum halli Milne-Edwards and Haime	x	...	x	x	x	...	x	...	x
Zaphrentis prolifica Billings	...	x	...	x	x	...	x	...	...
Zaphrentis simplex Hall	x	...	...	...	...	...	...	...	x

TABLE SHOWING CORRELATION OF SILICA SHALE FAUNA WITH SOME MIDDLE DEVONIAN FAUNAS IN OHIO AND ELSEWHERE—Continued.

List of fossils from the Silica shale	Ohio				Ontario			Maryland	New York
					Hamilton formation				
	Traverse	Olentangy	Delaware	Columbus	Widder	Olentangy	Alpena	Hamilton	Hamilton
Vermes									
Spirorbis arkonensis Nicholson					x				x
Spirorbis planum n. sp.									
Crinoids									
Arthracantha carpenteri (Hinde)					x				x
Hexacrinus (?) sp.									
Crinoid fragments									
Bryozoa									
Acanthoclema sulcatum Hall and Simpson									x
Botryllopora socialis Nicholson					x				x
Cystodictya incisurata (Hall)	x				x	x			x
Fenestella sp.									
Fistulipora vesiculata (Hall and Simpson)			x		x				x
Hederella canadensis (Nicholson)		x			x	x			x
Hederella cirrhosa Hall					x	x			x
Hederella magna Hall					x				x
Intrapora (?) irregularis n. sp.									
Monotrypella ohioensis n. sp.									
Monotrypella sp.									
Paleschara (?) sp.									
Reptaria stolonifera Rolle									x
Reteporina striata (Hall)	x				x				x
Stictoporina granulifera n. sp.									
Streblotrypa hamiltonensis (Nicholson)	x	x			x	x			x
Brachiopods									
Ambocoelia umbonata (Conrad)	x	x	x		x			x	x
Athyris vittata Hall	x				x	x	x		x
Atrypa reticularis (Linnaeus)	x	x	x	x	x		x	x	x
Camarotoechia prolifica Hall (?)			x					x	x
Chonetes coronatus (Conrad)	x	x	x		x			x	x
Chonetes fragilis n. sp.									
Craniella hamiltonae Hall		x			x			x	x
Crania sp.									
Cyrtina hamiltonensis	x	x	x	x	x	x		x	x

TABLE SHOWING CORRELATION OF SILICA SHALE FAUNA WITH SOME MIDDLE DEVONIAN FAUNAS IN OHIO AND ELSEWHERE—Concluded.

List of fossils from the Silica shale	Ohio				Ontario			Maryland	New York
					Hamilton formation				
	Traverse	Olentangy	Delaware	Columbus	Widder	Olentangy	Alpena	Hamilton	Hamilton
Brachiopods									
Leiorhynchus lucasi n. sp.									
Pholidostrophia iowaensis (Owen)	x	...	x	x	x	...	...	.....	x
Productella spinulicosta Hall	x	...	x	x	x	x	x	cf.	x
Rhipidomella vanuxemi Hall	x	...	x	x	x	...	...	x	x
Schizophoria striatula (Schlotheim)	x	x	...	...	...	...	x	x	x
Schizophoria striatula v. parvum n. var.									
Spirifer audaculus (Conrad)	x	...	x	...	x	...	...	x	x
Spirifer bownockeri n. sp.									
Spirifer euryteines Owen	...	...	...	...	x	...	...	.....	x
Spirifer mucronatus v. prolificum n. var.									
Stropheodonta demissa (Conrad)	x	x	x	x	x	...	...	x	x
Stropheodonta (Leptostrophia) perplana (Conrad)	x	x	x	x	x	...	x	x	x
Pelecypods									
Actinodesma erectum (Conrad)	x	...	x	...	...	x	...	.....	x
Grammysia bisulcata (Conrad)	...	x	x	...	...	...	...	x	x
Modiomorpha concentrica Hall	...	...	...	x	...	...	...	x	x
Modiomorpha mytiloides (Conrad) (?)	...	...	...	...	...	...	...	x	x
Pterinea flabellum (Conrad)	x	x	...	x	x	...	...	x	x
Gastropods									
Platyceras bucculentum Hall	...	...	x	x	x	...	...	.....	x
Platyceras carinatum Hall	...	...	x	x	x	...	x	.....	x
Platyceras rarispinum Hall	...	...	...	x	x	x	...	.....	x
Diaphorostoma lineatum (Conrad)	x	...	...	x	x	...	...	x	x
Pteropods									
Styliolina fissurella (Hall)	...	x	...	...	x	x	...	x	x
Tentaculites bellulus Hall (?)	x	...	...	...	x	x	...	x	x
Cephalopods									
Protokionoceras sp.									
Trilobites									
Phacops rana var. milleri n. var.									
Ostracods									
Cytherella (?) bispinulatus n. sp.									

DESCRIPTION OF SPECIES

No attempt has been made to give a complete synonomy for the species. In some cases only the original descriptive article has been listed, while in others references were added which were considered by the writer to be of most value to students of paleontology.

PLANT KINGDOM

Plants, presumably seaweeds, are abundant at the contact of the shale with the overlying limestone layer. The branches stand out in distinct relief on the lower surface of the limestone and are shown on the loose blocks of limestone lying about on the floor of the quarry. The seaweeds consist of branching stems radiating from centers, the largest stems often attaining diameters of 3 inches, with small ones an inch or so in diameter branching off from them. No structure could be detected in any of the specimens examined and no attempt at identification has been made. The abundance of such material at this one horizon is extremely interesting and is worthy of further study.

ANIMAL KINGDOM

PHYLUM COELENTERATA

Class *Anthozoa*
Subclass *Tetracoralla*
Genus *Zaphrentis* Rafinesque

Zaphrentis prolifica Billings

Plate I, Fig. 1.

1858. *Zaphrentis prolifica* Billings, Report of Progress for 1857, Geol. Surv. of Canada, p. 176.
1874. *Zaphrentis prolifica* Nicholson, Paleo. of Ont., p. 23, pl. 3, figs. 2, 2a; and 1875, Geol. Surv. of Ohio, vol. 2, p. 237.
1876. *Zaphrentis prolifica* Rominger, Geol. Surv. Mich., vol. 3, pt. 2, p. 147, pl. 53, upper row.
1901. *Streptelasma prolificum* Lambe, Contrib. to Can. Paleo., vol. 4, pt. 2, p. 115, pl. 8, figs. 1, 1a.

Description.—Lambe's description is as follows: "Corallum simple, conical, slightly curved, pointed and sometimes attenuated at the base, often annulated by well marked rounded growth ridges. Epitheca complete, showing fine transverse growth lines and longi-

tudinal septal furrows. Corallum attaining a length of as much as 165 mm., measured on the convex curve, with a breadth at the cup rim of about 60 mm., but with an average size in small specimens of between 50 and 70 mm. in length by 25 to 35 mm. in diameter above, with all gradations between these extreme sizes. Calyx with steep walls, its depth often nearly equal to about one-half the height of the corallum, in large specimens not quite so deep. Septa well developed, of two sizes, alternating, some of the primaries generally extending to the center where they are twisted, the secondaries equal in length to about one-sixth the diameter of the corallum; in large specimens numbering up to about one hundred and thirty or even more, in small specimens from 90 to one hundred. Dissepiments occupying the interseptal loculi, large, arching from the walls upward and inward toward the center where they are more or less horizontal and often contorted and twisted. The inner ends of the primary septa appear in the broadly convex cup bottom as sharp-edged converging keels that either combine at the center to form a more or less exsert laterally compressed boss, or become twisted together without the formation of a decidedly central prominence, or, as is not infrequently the case, the center may be smooth and comparatively free of septa. The primary septa often coalesce in twos and threes near their inner ends. A deep lateral septal fossette is present in the bottom of the calyx and extends toward the center in line with the longer axis of the central projection; its position is independent of the curvature of the corallum. In the calyx the septa gradually change into low, rounded ridges as the rim is approached." Lambe, 1901, reference above.

Remarks.—This species is apparently sparingly represented in the shale since only two or three specimens have been obtained. Rock filling obscures some of the calyx features but so far as can be observed our specimens conform to the characteristics of the species. A typical specimen measures 45 mm. in length and 32 mm. in width at the calyx margin. The septa, alternating in size, number 120, the primary ones almost reaching the center and slightly bent. The epitheca is wrinkled by growth annulations and marked by longitudinal striae corresponding with the septa. A low basin-shaped corallum with constricted calyx rim is also assigned to the same species.

Zaphrentis simplex Hall

Plate I, fig. 2

1884. *Streptelasma simplex* Hall, Thirty-fifth Ann. Rept. N. Y. State Mus. of Nat. Hist. p. 422, pl. 23, figs. 8, 9.
1909. *Zaphrentis simplex* Grabau and Shimer, p. 57, fig. 82.

Description.—Corallum simple, turbinate, curved, pointed at the base. Epitheca thin, wrinkled by growth annularions, showing

longitudinal septal furrows. The dimensions of a typical specimen are length 36 mm., width at calyx rim 20 mm. Calyx with steep walls, deep, nearly one-half the height of the corallum. Septa 40, well developed in the calyx, of equal length, apparently almost reaching the center. Character of fossula obscure. Dissepiments few; tabulae not observed.

The species is rare and only a few specimens have been collected.

Genus *Cystiphyllum* Lonsdale

Cystiphyllum vesiculosum Goldfuss

1826. *Gyathophyllum vesiculosum* Goldfuss, Petrefacta Germaniae, vol. 1, p. 58, pl. 17, figs. 5a-e, and plate 18, figs. 1a-d.
1876. *Cystiphyllum americanum* Rominger, Geol. Surv. Mich., Foss. Corals, p. 137, pl. 50, upper row and right-hand half of lower row.
1899. *Cystiphyllum vesiculosum* Lambe, Ottawa Naturalist, vol. 12, p. 257.
1901. *Cystiphyllum vesiculosum* Lambe, Contrib. to Can. Paleo., vol. 4, pt. 2, p. 192.

Description.—This species is discussed by Lambe as follows: "Corallum simple, varying from turbinate to conico-cylindrical, pointed at the base, straight or curved, flexuous or geniculated, sometimes long and slender, at other times comparatively short and thick. Annulated by growth expansions and constrictions, in some specimens much more pronounced than in others, frequently contracted at the calicular end. Epitheca complete, thin, showing minor rings of growth, the whole marked by fine, transverse lines, of which in well preserved specimens, as many as twenty-four can be counted in a space of 2 mm.; faint longitudinal indications of linear septal markings are also not infrequently developed. Calyx of variable depth; in short turbinate coralla comparatively shallow, often with broad margins; in more cylindrical forms generally somewhat deeper in proportion to the diameter and with steeper sides. Surface of calyx blistered and often marked radially by interrupted, more or less distinct superficial septal ridges. Inner structure entirely vesiculose, composed of convex, blister-like plates resting on each other and directed obliquely outward and upward to the periphery; at the center of the visceral chamber the vesicles are more nearly horizontal and as a rule larger than the others.

"This species is very variable in shape and size, sometimes in the stout, short forms reaching a diameter of 10 cent. with a length of about 27 cent. in the slender forms and an equal length may be obtained with a thickness of only 3 or 4 cent." Lambe, 1901, reference above.

Remarks.—Our collection contains a few specimens which belong to this genus but their condition of preservation is not such as to permit positive specific identification and the chief reason for assigning them

to this species is because it is the most common and widespread one of the genus. The irregular growth of the corallum, absence of regular septa, blistered character of the calyx, and the wrinkled epitheca prove the correctness of the generic determination. The best preserved specimen measures 25 mm. in width and 18 mm. in length.

Genus *Heliophyllum* Hall

Heliophyllum halli Milne-Edwards and Haime

Plate I, fig. 3

1851. *Heliophyllum halli* E. and H., Polyp. Foss. des Terr. Palaeoz., p. 408, pl. 7, figs. 6, 6a, 6b.
1876. *Cyathophyllum halli* Rominger, Geol. Surv., Mich., vol. 3, pt. 2, p. 99, pl. 35.
1899. *Cyathophyllum halli* Lambe, Contrib. to Can. Paleo., vol. 4, pt. 2, p. 148.
1911. *Heliophyllum halli* Cleland, Wis. Geol. Surv. Nat. Hist., p. 28, pl. 1, fig. 5.

Description.—A few specimens in our collection belong to this common and characteristic Middle Devonian species. In conformity with the common examples of the species the corallum proceeds from a narrow, pointed base and is extremely irregular in its habit of growth, exhibiting numerous annular constrictions and swellings. The septa alternate in size, the primary ones not quite reaching the center and the secondaries reaching at least half way, about 100 being present in a specimen having a diameter of 32 mm.; carinate generally but carinae never developed to a conspicuous degree. The center of the calyx is occupied by a small flat tabulum. The vesicules in the septal interspaces outside the tabulate zone are well shown in weathered places where the epitheca has been worn away. An adequate description has not been attempted and the reader is referred to the references listed above.

The dimensions of the largest and most complete example are length 52 mm., greatest diameter 32 mm.

Subclass *Tabulata*

Genus *Aulopora* Goldfuss

Aulopora serpens Goldfuss (?)

Plate I, fig. 4

1876. *Aulopora serpens* Rominger (?), Geol. Surv. Mich., vol. 3, pt. 2, p. 87, pl. 33, fig. 2.
1885. *Aulopora serpens* Davis, Kentucky Geol. Surv., Mono. Ky. Foss. Corals, pt. 2, pl. 74, figs. 1, 2.

Description.—Corallum prostrate, attached by the under surface to other organisms, especially to brachiopod shells; consisting of oblique.

conical, anastomosing tubes forming a network, and branching from buds which originate just below the orifice of the calyx. One, and sometimes two tubes ascend, and occasionally are united by their walls to the parent for a short distance, hence often making the colony appear compact and crowded. Calyx bent into an upright position near the end. The corallites commonly vary in width from 2 to 3 mm., and rarely larger ones occur.

Remarks.—Specimens of the writer differ from the typical species in the larger size of the corallites and their closer arrangement in some specimens. As a rule the tubes of *Aulopora serpens* have a diameter ranging from 1 to 2 mm., while the average of the examples under discussion is somewhat greater than this. The specimens are, however, very similar in general appearance and size to the figured examples from the Lower Devonian of Kentucky in the reference quoted above.

Genus *Ceratopora* Grabau

Ceratopora flabellata Greene

Plate I, fig. 5

1902. *Ceratopora flabellata* Greene, Contrib. to Indiana Paleontology, pt. 9, p. 75, pl. 25, figs. 2, 3, and 4.
1911. *Ceratopora flabellata* Cleland, Wis. Geol. Surv., Bull. 21, p. 34, pl. 2, fig. 7.

Description.—Corallum quite compact for genus, the corallites usually increasing by lateral gemmation, one and sometimes two tubes budding off just below the calyx aperture. Corallites usually closely disposed, sometimes connected for nearly the entire length, increasing in diameter fairly rapidly and opening obliquely on the surface. Diameter of tubes varies from 2.5 to 3 mm. in the same corallum, and the length varies from 5 to 10 mm. The thickened lamellose walls are a conspicuous feature, but due to the unsatisfactory condition of preservation the spines which characterize the inner walls of the corallites in this species apparently have not been preserved, nor is there any evidence of their bases. External surface generally smooth.

Remarks.—The corallites appear to taper rather more than is common in the species, and the annular lines of growth are barely perceptible, but otherwise there is a close agreement with the published figures and descriptions, and the determination is made with considerable confidence.

Ceratopora jacksoni Grabau

Plate I, fig. 6

1899. *Ceratopora jacksoni* Grabau, Boston Society Natural History Proceedings, vol. 28, p. 415, pl. 1, figs. 1, 2, 3; pl. 2, figs. 6-10.
1911. *Ceratopora jacksoni* Cleland (?), Wis. Geol. Surv., Bull. 21, p. 36, pl. 1, fig. 7.

Grabau's description.—"Corallum erect, frequently and irregularly branching; corallites cylindrical or slightly trumpet-shaped. Surface formed by a coarsely wrinkled epitheca, and showing longitudinal ridges or costae. Cavity of the calyx funnel-shaped, continued as a cylindrical central tube which seldom occupies more than one third of the diameter of the corallite. Cysts coarse, irregular, arranged semiconcentrically with frequent spine-like processes or trabeculae projecting from the lamellae of the wall. The branching of this species is such as to produce an irregular arborescent form, indicating that the corallum grew upright. The corallites seldom grew perfectly cylindrical and erect, almost always having a more or less sinuous or irregular outline. The new buds were usually given off at an oblique angle." Grabau, 1899, reference above.

Remarks.—Some rather poorly preserved fragments are referred to this species because of the resemblance in size, coarsely wrinkled epitheca, and costal ridges. They do not show the internal features which characterize the genus and species.

PHYLUM VERMES

Class *Chaetopoda*
Order *Tubicola*
Genus *Spirorbis* Daudin

Spirorbis arkonensis Nicholson

1874. *Spirorbis arkonensis* Nicholson, Rep. Paleo. Prov. Ont., p. 121, figs. 54 b, c.

Description.—Shell minute, about .50 mm. in diameter at greatest width, somewhat globular, consisting of two rounded whorls attached by the under surface. The tube increases fairly rapidly in size and the outer whorl is considerably raised above the inner. Aperture circular. Surface marked by fine, rather widely separated annulations or ridges. Only dextrally coiled specimens have been observed.

Remarks.—Identification with the above species is open to question since the surface sculpture in *Spirorbis arkonensis* consists of fine transverse striae, while the specimens under discussion are characterized by very fine annulations or ridges. However in other essentials there is a close agreement and it seems best to identify our specimens as indicated. The minute size and rounded whorls readily separate this species from the next. In Plate 3, figure 11 shows a few of these minute shells attached to *Stropheodonta perplana*.

Spirorbis planum n. sp.

Plate I, figs. 7, 8

Description.—Tube angular, forming a regular coil in one plane,

enlarging very gradually in diameter, the upper surface flat and either horizontal or slightly inclined to the umbilical margin. Generally from two to three coils occur. The surface in some specimens is smooth, but in others which are well preserved the umbilical margin is noticeably plicate. The aperture has not been seen on any of the specimens but evidently is at right angles to the plane of the coils and is laterally compressed. Individuals vary in size from .5 to 2 mm. across the coiled tube, the small specimens doubtless being young ones.

Remarks.—In the plicate character of the umbilical margin this species resembles *Spirorbis omphaloides* but differs in the more consistent and pronounced angularity of the whorls and in the flatness of the upper surface. All specimens which have been seen are attached to shells of *Modiomorpha concentrica.*

Holotype No. 16,264 Geological Museum, Ohio State University.

PHYLUM ECHINODERMATA

Class *Crinoidea*
Order *Camerata*
Genus *Arthracantha* Williams

Arthracantha carpenteri (Hinde)

Plate I, figs. 9-11

1885. *Hystricrinus carpenteri* Hinde, Ann. Mag. Nat. Hist. 15: 162, pl. 6.
1923. *Arthracantha carpenteri* Goldring, N. Y. State Mus. Mem. 16, p. 288-291; pl. 60, figs. 1-3.

Description.—Calyx large, broadly conical in mature specimens, expanding regularly from the base to the top of the dorsal cup; broader than high, the greatest width in the region of the primibrachs; some specimens slightly compressed laterally; plates of dorsal cup consisting of basals and radials. The measurements of a fairly complete dorsal cup of average size are height 27 mm., width at top of radials 35 mm. A smaller specimen which has the tegmen preserved measures 33 mm. from base to the top of the tegmen and 28 mm. wide at top of the radials.

Base monocyclic, consisting of three large plates which are about equal in size, and form a broad low cup with a height nearly one-third that of the entire dorsal cup. Sutures between adjoining basal plates straight and clearly defined.

Between the basals and proximal margin of the radials the suture lines are for the most part irregular and jagged. The unevenness of these sutures is extremely interesting and is a more or less conspicuous feature of all the specimens examined, being more pronounced in old specimens than in young. According to Miss Goldring[1] this is not a

[1]Personal communication, November 1926.

character of specific importance but is a condition of the growth of the plates probably dependent upon some environmental condition. Just why this condition should prevail at the contact of the basals and radials and practically never at the contact of any of the other plates is not clearly understood by the writer, and it seems possible is not entirely dependent upon external factors.

Upper part of calyx consists of 5 radials and an anal plate in lateral contact. The radials are generally rectangular in outline, but show considerable variation in form and proportions in the same specimen. The two postero-lateral radials are smaller than the others and broaden quite noticeably from proximal to distal margin; anterior radial somewhat larger and broadening only slightly; antero-lateral radials most nearly rectangular of all but either may be wider than the other. Anal plate almost perfectly rectangular in outline. Sutures between plates straight and well defined. Distal margin notched at junction of adjoining plates for the insertion of the interradial tegminal plates.

Arm facets distinct, hemispherical, arching upward and away from the surface of the plates.

Tegmen low, depressed in the central part, consisting of numerous irregularly shaped plates which are smallest in the central part of the tegmen. In each interradii excepting the posterior there are 3 or 4 tegminal plates in the first series, irregular in shape and size and followed by many smaller interambulacral plates. In the posterior interradius there are from 5 to 8 tegminal plates in the first row also extremely diverse in size and shape and with smaller interambulacral plates towards the center of the tegmen. The anus is situated within an excentrically placed conical protuberance covered with a number of small plates. In all the interradii the outside plates of the first row are united laterally with the arm plates up to and including the lower secundibrachs.

Only the lower part of the arms showing the primibrachs and the lower secundibrachs have been seen. There are 2 primibrachs, the primaxial the wider of the two plates. Arms biserial above the third or fourth secundibrach in mature specimens but not appreciably flattened on the dorsal surface as is sometimes true of the arms in this species. The two dorsal rows of minute granules are only faintly developed or wanting entirely. Pinnules not preserved.

Plates of dorsal cup, tegmen, and arms ornamented with tubercles which are pitted for the attachment of spines. They are most abundant on the basals and radials, and have little definite arrangement apart from the fact that on the radials they are crowded and larger in the distal portion and in the region of the arm facets. In some specimens the tubercles are more numerous on the basals while in others they are more numerous on the radials. Only a few scattered tubercles have

been observed on the lower brachials. On the plates of the tegmen the tubercles are irregularly disposed; in the lower series some plates have 4 or 5, other plates throughout the tegmen have only one or two, and some are entirely free from tubercles. The spines have not been seen attached but they are abundant in association with specimens being most commonly pressed against the sides of the calyx. Spines up to 4 mm. in length occur but most of them are much shorter.

Column round, composed of thin discs.

Remarks.—The collections contain a number of excellent specimens of this species which show the dorsal cup and the lower arm plates, and in some cases the tegmen. It was recognized that the full-grown specimens were larger than is common to the species, the tubercles exceptionally variable in size, number, and arrangement, the suture lines between the basals and radials uneven, and a fourth interradial plate present in some specimens. For these reasons it was thought that some of these specimens might belong to a species other than *Arthracantha carpenteri*, to which species some of them were assigned. Accordingly the collection was submitted to Miss Goldring who expressed her opinion that the specimens were an ontogenetic series belonging to one species *Arthracantha carpenteri*, the differences noted being only what might be expected wherever a good ontogenetic series could be obtained. The ontogeny of the species is an interesting problem and it is hoped that sufficient additional material can be obtained to justify a study of this problem at some later time.

Five out of the 15 or 20 specimens examined have the gastropod *Platyceras* attached to the ventral side. The association of this particular group of gastropods with crinoids is common and seems to be particularly characteristic of this species of crinoid. The attachment seems to have existed throughout life because the contour of the gastropod shell usually conforms to the irregularities of the crinoid. Moreover this relationship seems to have continued without detriment to either one since the normal growth of the individuals concerned does not seem in any case to have been retarded or seriously interfered with.

Genus *Hexacrinus* Austin

Hexacrinus (?) sp.

One specimen in the collection resembles *Arthracantha carpenteri* but the plates are free from spine-bearing tubercles. It is therefore placed provisionally in the above genus which differs from *Arthracantha* in the absence of the tubercles and in having uniserial instead of biserial arms. Only the lower brachials are preserved and are not sufficient for determination of the arm structure. Until specimens are available to show this latter feature the one under discussion cannot be ascribed definitely to any genus.

Crinoid fragments

Plate I, figs. 12-15

Crinoid stems and spines are numerous in the shale and indicate a greater abundance of crinoids than the few calices which have been discovered would lead us to believe. The most common type of stem is composed of circular plates about 6 mm. in diameter and with round, medium-sized axial canal. Another column has the surface regularly spinose and the canal circular and minute. The specimens figured illustrate some of the common types.

PHYLUM MOLLUSCOIDEA

Class *Bryozoa*
Order *Cyclostomata*
Genus *Hederella* Hall

Hederella canadensis (Nicholson)

Plate I, figs. 16, 17

1874. *Aulopora? canadensis* Nicholson, Pal. Province Ontario, p. 124, fig. 57 a-e.
1887. *Hederella canadensis* Hall and Simpson, Pal. New York, vol. 6, p. 277, pl. 65, figs. 1-8, 14 and 16?.

Description.—This species is discussed by Hall and Simpson as follows: "Zoarium parasitic, procumbent, attached for its entire length; usually occurring on corals or brachiopods, most frequently on *Heliophyllum halli*. It consists of a primary cylindrical tubular axis which has lateral tubular cells at frequent intervals, and occasionally cells having the same manner of growth as the primary axis. This mode of growth is indefinitely continued so that large surfaces are covered by the zoarium. The cell tubes are subcylindrical, at first rapidly expanding, but for the greater portion of their length the margins are parallel; transverse section oval in outline, length from 1.25 to 2 mm., diameter .33 mm., generally arranged in alternating order, and often regularly distant on the same side of the branch 1.50 mm.; the angle of divergence from the axial tube is sometimes forty-five degrees, at other times they are in contact with the axis for nearly their entire length, turning abruptly outward near the end, the apertures being parallel with the axis of the branch and a little constricted; during the process of growth the apertures are rectangular to the axis. Surface marked by numerous strong transverse striae with finer striations between, and frequently the stronger striae have the appearance of prominent annulations. The cell tubes vary in their surface characters, some of them having only the prominent annulations, others only the finer striae, while

still others have both the annulations and the finer striations, and when well preserved they have also numerous, very fine longitudinal striae." Hall and Simpson, 1887, reference above.

Remarks.—Specimens of this beautiful branching bryozoa are of frequent occurrence in the shale and are commonly found attached to brachiopod shells, *Spirifers* and *Chonetes* being especially in evidence. The fronds are comparatively large, some specimens covering almost an entire valve. The form may be distinguished from the associated species *Hederella cirrhosa* by the larger size of the cell tubes and the generally more compact appearance of the colony due to the closer arrangement of the cell tubes. From *Hederella magna* it is readily separated by its smaller size.

This species is also present in the Olentangy shale of central Ohio.

Hederella cirrhosa Hall

Plate I, fig. 18

1883. *Hederella cirrhosa* Hall, Trans. Albany Institute, vol. 10, p. 194 (abstract, 1881, p. 194).

1887. *Hederella cirrhosa* Hall and Simpson, Pal. New York, vol. 6, p. 277, pl. 65, figs. 12, 13.

Remarks.—The slender filiform appearance of this delicate bryozoa is the character by which Hall separates it from associated species. This in general is true of our specimens although there are intermediate types which in size of cell tubes and compactness of colony closely approximate *Hederella canadensis*. In typical specimens the tubes are about 1 mm. in length and .20 mm. in diameter. They are generally alternating on the branch, are circular in cross section, and the aperture is nearly parallel with the axis of the branch. The fronds are commonly attached to *Spirifer* and *Chonetes* shells.

Hederella magna Hall

Plate I, fig. 19

1883. *Hederella magna* Hall, Trans. Albany Institute, vol. 10, p. 195 (Abstract, 1881, p. 195).

1887. *Hederella magna* Hall and Simpson, Pal. New York, vol. 6, p. 28, pl. 65, fig. 15.

Description.—One frond occurring on a *Spirifer* shell is considerably larger than those of the two associated species of *Hederella*. The dimensions are diameter of tubes a little less than 1 mm., length from 2 to 3 mm. The cell tubes are arranged in alternating order on the branch and their surfaces are marked by fine transverse striae and

strong annulations. In size the specimen is intermediate between *Hederella filiformis* and *Hederella magna*, the former having cell tubes a little more than .50 mm. in diameter and from 1 to 1.25 mm. in length, the latter with cell tubes a little more than 1 mm. in diameter and from 2 to 3 mm. in length. It is the opinion of the writer that the specimen under discussion more nearly approaches the latter species with which it is here identified.

Genus *Reptaria* Rolle

Reptaria stolonifera Rolle

Plate II, figs. 1, 2

1887. *Reptaria stolonifera* Hall and Simpson, Pal. New York, vol. 6, p. 274, pl. 65, figs. 17-19.

Hall's description in part.—"Zoarium parasitic, procumbent, attached for its entire extent; consisting of a rachis from which proceed laterally at regular intervals simple cell tubes, and at irregular distances tubes which have the same manner of growth as the primary rachis; this mode of growth is continued indefinitely the frond covering a comparatively large area. Cell tubes subcylindrical, sinuous, especially near the base, the attached portion flat, the free portion convex; length about 2 mm., width .50 mm.; turning abruptly outward at the extremities, the apertures being parallel with the axis of the branch and broadly oval, generally alternating, occurring at intervals of about 1.33 mm.; for a short distance they are nearly parallel with the rachis, then diverging at an angle of from 35 to 40 degrees; margins of the branches in contact but not coalescing, the end of each succeeding cell tube projecting beyond the previous one, giving a serrated appearance to the margin of the frond. In well-preserved specimens the cell tubes are strongly annulated and generally obscurely angular along the middle, giving the annulations the appearance of a row of nodes; on some portions of the frond the cells are not angular, but the annulations still have somewhat the appearance of nodes along the middle of the tube; the annulations are broad, abruptly rounded, three in the space of 1 mm., with indications of faint longitudinal striations." Hall and Simpson, 1887, reference above.

Remarks.—Two fragments of cephalopods are partly covered with fronds of this unique and rare Hamilton bryozoa. The longest frond observed is 25 mm. in length, and the average width is about 3 mm. Because of the proximity of the branches the frequency of branching cannot be determined but since in places the entire surface is covered it is likely that the branching is more frequent than is shown on the New York figured specimens, and that several branches proceed

from the same base. The species is characterized by the long, almost straight stipe, and the parallel and exceedingly regular arrangement of the zooecial tubes. It can be readily distinguished from *Hederella canadensis* because of the less diversified appearance of the frond and the more closely arranged and parallel cell tubes.

Genus *Fistulipora* M'Coy

Fistulipora vesiculata (Hall and Simpson)

Plate II, figs. 3, 4

1887. *Lichenalia vesiculata* Hall and Simpson, Pal. New York, vol. 6, p. 198, pl. 57, figs. 14-19; pl. 59, figs. 1, 14.

Remarks —Specimens consisting of more or less massive types and of lamellate expansions have been assigned to this species, the latter having a thickness of from 1 to 5 mm. The form is characterized by the circular to trilobate cell apertures with conspicuously elevated peristomes; comparatively large and angular vesicules which in places are clustered together to form maculae; cell tubes with irregularly disposed diaphragms, and an abundance of vesicular tissue. Examples showing a considerable range in size, shape, and distribution of apertures have been studied. The significance of these differences is difficult to evaluate, and since no consistent differences for specific distinction have been found among the specimens, it seems best to group them under the same species.

Genus *Botryllopora* Nicholson

Botryllopora socialis Nicholson

Plate II, figs. 5, 6

1887. *Botryllopora socialis* Hall and Simpson, Pal. New York, vol. 6, p. 282, pl. 64, figs. 3, 4.

Description.—This singular bryozoa is represented in the collections studied by a group of zoaria incrusting a colony of *Fistulipora vesiculata*. The specimens entirely conform to Hall and Simpson's description which is quoted in full: "Zoarium consisting of small discoid bodies, occurring singly or in groups, connected by vesicular tissue, adherent to foreign bodies by their under surface which consists of a concentrically wrinkled epitheca. Nearly all the specimens observed are parasitic on Cyathophylloid or Favositoid corals, sometimes occurring in groups of from seventy-five to a hundred zoaria; each one having a diameter of from 3.5 to 4 mm.; convex, with a concave central area, which is somewhat variable in size, but usually from 1 to 1.50 mm. in

diameter. Cells tubular, rectangular to the surface, disposed in double radiating rows, extending above the surface and forming prominent ridges about .30 mm. in width; adjacent ridges generally separated by a space about equal in width to that of a ray, but sometimes more closely disposed. Alternate ridges extend from the margin to the depressed central area, the others from one-half to two-thirds that distance. Cell apertures minute, circular, diameter .10 to .12 mm., in contact, often inosculating, having the appearance of being immersed. Each zoarium has from twenty to twenty-four rays, or from forty to forty-eight ranges of cells. Intercellular space vesiculose, vesicules comparatively large and irregularly disposed.

"The concave central space lying between the ridges of apertures and between the zoaria forming the colony, is bullate; the bullae in the central space have a diameter of from .15 to .25 mm. and are polygonal; those between the ridges are much smaller, having a diameter of from .6 to .10 mm.; those between the individual zoaria are of two kinds, one circular or subpolygonal from mutual pressure, the diameter generally from .50 to .60 mm., rarely a little more; these are very frequently in contact, and when separated the space between them is occupied by bullae similar to those between the celluliferous ridges. When the surface becomes worn the upper walls of the bullae or vesicules are worn or broken away, they have the appearance of shallow pits." Hall and Simpson, 1887, reference above.

Order *Trepostomata*
Genus *Monotrypella* Ulrich

Monotrypella ohioensis n. sp.

Plate II, figs. 7-10

Description.—Zoarium ramose, often in discoidal masses from which several branches diverge. Zooecial apertures angular, irregular in shape and size, from 5 to 7 in 2 mm. Mesapores wanting, the small angular cells seen in tangential sections being young zooecia. Cell tubes polygonal, frequently becoming narrower where new zooecia are introduced, diverging gently from the axis until the mature region is reached and then turning abruptly to meet the surface at right angles. Diaphragms wanting in axial region, quite closely disposed in mature part where they are usually horizontal although some oblique ones also occur. Towards the peripheral margin the walls become thicker.

Remarks.—This form has its nearest affinity in *Monotrypella arbusculus* from the Lower Helderbergian of New York but can be distinguished by the thicker branches, more massive form of growth, and the thickened walls in the mature part. From *Eridotrypa appressa* Ulrich of the Hamilton of Illinois and Iowa it may be separated by its

different manner of growth and the greater abundance of diaphragms in the zooecial tubes.

Holotype No. 16,267, Geological Museum, Ohio State University.

Monotrypella sp.

Plate III, fig. 1.

Description.—Zoarium in thin, incrusting masses, about 1 mm. in thickness. Surface smooth. Zooecial apertures minute, polygonal, in contact, from 5 to 6 in the space of 1 mm. Mesapores and acanthopores absent. Zooecial tubes straight, fairly thick-walled, opening directly on the surface. Diaphragms lacking.

A few fronds incrusting brachiopod shells and a small free conical zoarium seem to meet the requirements of the above genus although not entirely typical. Whether these specimens represent a new species is not altogether clear. The smaller zooecia and lack of diaphragms serve to distinguish it from the associated *Monotrypella ohioensis*.

Fenestellid fragments

Numerous fragments of bryozoa belonging to the genus *Fenestella* have been found but unfortunately are too poorly preserved to be identified with confidence. Some fragments resemble *Fenestella emaciata* in the oblique and slender dissepiments and in the longitudinally striated branches on the reverse side. Others are more delicate in appearance and the dissepiments on the obverse side are marked by closely spaced nodes, these evidently belonging to another species. Additional and better preserved material is necessary for accurate determination.

Order *Cryptostomata*
Genus *Reteporina* d'Orbigny

Reteporina striata (Hall)

Plate II, figs. 11, 12

1887. *Fenestella* (*Reteporina*) *striata* Hall, Sixth Ann. Rept. State Geologist New York for the year 1886, p. 45, pl. 3, figs. 1-6.

Description.—A detailed description of this species is given in the reference listed above. The few fragments in the writer's collection, although not entirely typical, nevertheless show a marked resemblance to this species. The reverse side of the frond presents the regularly reticulate surface characteristic of the species. The fenestrules are both oval and rhomboidal in outline, the latter type prevailing. The nodes which are commonly present at the junction of the branches and

dissepiments are either poorly developed or absent. A thin section reveals the sinuous branches of the obverse side, the regularly oval fenestrules and the cell apertures in two rows of which about 25 occur in 5 mm. In this latter respect there is a departure from the species as described by Hall for generally 18 occupy a similar space. Since it was possible to count the apertures in only a very small space it is a matter of question whether this more closely spaced condition is a persistent feature. If this larger number is persistent our form may represent a distinct species.

Genus *Acanthoclema* Hall

Acanthoclema sulcatum Hall and Simpson

Plate II, figs. 13, 14

1887. *Acanthoclema sulcatum* Hall and Simpson, Pal. New York, vol. 6, p. 192, pl. 50, fig. 7; pl. 55, fig. 7.

Description.—Specimens of bryozoa from the Silica shale show fairly closely the characters of this neat little species. The zoarium is ramose, the branches having a diameter of about .50 mm., only one bifurcation having been observed on any of the fragments examined, the longest of which measures 8 mm. The cell apertures are oval, 3 occurring in the space of 1 mm., and are separated by about one-half their length, being typically arranged in longitudinal, parallel rows. So far as can be observed, there are 6 rows to a branch, separated by well-defined granulose ridges the crests of which are usually above the peristomes of the apertures. The concavity of the surface between the ridges, mentioned by Hall and Simpson as characteristic of the species, is not a noticeable feature.

Remarks.—This minute form is rather rare and is most frequently found with *Streblotrypa hamiltonensis* from which it can be easily distinguished because of the longitudinal arrangement of the cell apertures and the prominent, granulose ridges. It is not exactly similar to the New York species since the cell apertures are more closely arranged and the concavity of the surface between the ridges is not so distinct. Nevertheless it seems that these differences are not of sufficient value to justify separation into another species.

Genus *Streblotrypa* Ulrich

Streblotrypa hamiltonensis (Nicholson)

Plate II, figs. 15, 16

1887. *Acanthoclema hamiltonense* Hall and Simpson, N. Y. Pal., vol. 6, p. 191, pl. 60, figs. 18-26.

Description.—Zoarium ramose, solid, growing up from a spreading base; the branches commonly from .50 to 1 mm. in diameter and bifurcating infrequently. The cell apertures are oval, from 3 to 4 occurring in the space of 1 mm., either longitudinally or spirally arranged, more commonly the latter; separated by more or less prominent sinuous ridges the continuity of which is often disturbed where the cells are irregularly disposed. The mesapores vary greatly in number and arrangement; usually there are 2 between adjoining zooecia, one situated above the other; often only one occurs, and then again the cell apertures are almost surrounded by the mesapores. The small node at the base of each aperture, mentioned by Hall and Simpson as typical of the species, has been rarely observed.

Remarks.—This species is present in extreme profusion, along with other bryozoa, in a thin layer near the contact of the shale with the underlying limestone. When the specimens are well preserved, which is most always true, the characteristic features of the species may be readily recognized. It is difficult to obtain entire fronds but fragments up to 15 mm. in length have been observed. The sinuous ridges between the apertures, and the angular mesapores, are the principal features by which the species may be separated from associated forms.

Genus *Stictoporina* Hall

Stictoporina granulifera n. sp.

Plate II, figs. 17-19

Description.—Zoarium a flabellate expansion, bifoliate, proceeding from a conically truncated base, increasing in width from 1 mm. at the base to 15 mm. at the greatest width which is about two-thirds the distance from the base, and from here the margins converge to the distally rounded frond. Entire length of an almost complete frond is 26 mm.; greatest thickness is 2 mm.; thickest in the basal portion, thinning toward the margins; lenticular in cross section. Cells tubular, without diaphragms, generally oblique towards the distal margin of the frond. Zooecial apertures oval, depressed, from .20 to .35 mm. in diameter, separated by about one-half the diameter of an aperture, outlined by polygonal, granulose ridges. In the cylindrical basal portion of the frond the cells are fairly uniform in size and are arranged in definite rows separated by granulose ridges, but about 5 mm. above the base they become irregular in shape and arrangement, and are appreciably smaller as the margin is approached. Low, flattened monticules, the centers of which are from 2 to 4 mm. distant, mark the surface. The apertures on these are larger than the others although here and there smaller ones are scattered among them.

Remarks.—The above description is based on one almost complete frond. The spreading zoarium, together with the flattened monticules with their slightly larger apertures, serve to distinguish this species from its nearest ally *Stictoporina plumea.*

Holotype No. 16,269, Geological Museum, Ohio State University.

Genus *Intrapora* Hall

Intrapora (?) *irregularis* n. sp.

Plate III, figs. 2-4

Description.—Zoarium a compressed lamellate expansion, bifoliate, about 1 mm. in thickness. Size of frond unknown but fragments up to 18 mm. in width have been observed. Zooecial apertures generally oval, but sometimes nearly circular or somewhat irregular; disposed comparatively close at variable distances; sometimes in contact. Length of oval cells .25 mm., width about two-thirds as great. Peristomes fairly strong, slightly elevated. Inter-zooecial space occupied by minute, angular mesapores, varying in size and irregularly arranged; sometimes a single series between apertures, sometimes more, and then again a number are clustered together to form maculae. A vertical section shows the thin-walled tubular zooecia and the tabulate mesapores parallel with the mesotheca for a short distance and then curving abruptly outward.

Remarks.—This species has been placed provisionally in the genus *Intrapora* for owing to the presence of pyrite it is practically impossible to obtain satisfactory sections without which positive generic determination is impossible, and although surficial details can readily be recognized the character of the tubes is more or less obscure. The species agrees in method of growth with *Intrapora puteolata*, but may be distinguished by the greater irregularity of the cell apertures, the more abundant mesapores, and especially by the presence of the maculae.

Cotypes No. 16,768, Geological Museum, Ohio State University.

Genus *Cystodictya* Ulrich

Cystodictya incisurata (Hall)

Plate III, figs. 5, 6

1887. *Stictopora incisurata* Hall and Simpson, Pal. N. Y. vol. 6, p. 241, pl. 60, figs. 1-18.

Description.—Excellently preserved specimens of this interesting bryozoa occur in abundance although entire fronds are scarce. The form is readily recognized by the flattened, dichotomously branching frond, the arrangement of the cell apertures in slightly divergent rows

which are separated by flat or rounded ridges about one-third the width of the aperture, and the lunarium which is developed to a greater or less degree in all of the apertures. In worn specimens the lunarium is not always distinguishable. The apertures are commonly oval but numerous circular ones also occur. In thin transverse sections the irregular vesicules which occupy the intercellular space are plainly shown. The branches commonly attain a width of from 2 to 3 mm. but occasionally ones up to 7 mm. in width have been recognized.

A detailed description of the species is given by Hall and Simpson in the reference quoted above.

Genus *Paleschara* Hall

Paleschara (?) sp.

Plate III, fig. 7

Description.—Whether this form is rightly placed in the above genus cannot be assured since the presence of pyrite prohibits the making of successful slides. The zoarium is incrusting, thin, about .50 mm. or less in thickness. Cells polygonal, in contact, varying greatly in shape and size, from 3 to 5 in 1 mm.; walls thin. Monticules prominent, distributed rather evenly over the surface, distant about 4 mm. Zooecia at base of monticules generally larger than the others.

The specimens observed are incrusting *Stropheodonta demissa* shells.

Class *Brachiopoda*
Order *Neotremata*
Genus *Crania* Retzius

Crania sp.

Description.—Shell subcircular or slightly elongate. Dorsal valve subconical; apex pointed and situated near the posterior margin; surface marked by concentric lamellose lines of growth. Posterior end slightly narrower than anterior. Shell substance thin, punctate. Ventral valve flat, concentrically marked. Internal characteristics not observed. The largest and most perfectly preserved valve measures length 9 mm., width 8 mm.

Remarks.—This small inarticulate brachiopod occurs attached to various *Spirifer* shells. The specific identity is doubtful since those that have come under observation are imperfectly preserved, and in no case have the internal characteristics been observed. Hence even the generic identification is uncertain. The form seems to be sparingly represented in the fauna and very few specimens have been collected.

Genus *Craniella* Oehlert

Craniella hamiltonae Hall

Plate III, fig. 8

1867. *Crania hamiltonae* Hall, Pal. N. Y., vol 4, p. 27, pl. 3, figs. 17-23.
1892. *Craniella hamiltonae* Hall and Clarke, Pal. N. Y., vol. 8, pt. 1, pp. 148, 153, pl. 41, figs. 3-16.
1913. *Craniella hamiltonae* Prosser, Md. Geol. Surv., Mid. and Up. Dev., p. 131, pl. 9, figs. 1-7.

Hall's description.—"Shell broadly oval or subcircular, dorsal valve subconical; apex subcentral or excentric, pointed in well preserved specimens, often worn or decorticated. Exterior surface of dorsal valve marked by concentric lamellose striae. Ventral or lower valve marked by four strong impressions of the adductor muscles, which are variable in form; the posterior ones are distant; the anterior ones approximate, diverging above and assuming a somewhat cordiform appearance, the pit for the protractor muscles occupying the space between. Vascular impressions strongly digitate." Hall, 1867, reference above.

Remarks.—Only a few imperfect dorsal valves have come under observation, but their general form and size agree so closely with this Hamilton species that they have been referred to it with considerable confidence. The dimensions of a large specimen are identical with those cited by Prosser[1] from Maryland, e. g., length 18 mm., width 19 mm. Smaller specimens occur but mostly in a crushed condition. The characteristic punctate shell structure has not been recognized on any of the specimens. The apex is worn and rounded and the lamellose concentric lines are prominent.

Order *Protremata*

Genus *Stropheodonta* Hall

Stropheodonta demissa (Conrad)

Plate III, figs. 9, 10

1842. *Strophomena demissa* Conrad, Jour. Acad. Nat. Sci., Phila., vol. 8, p. 258, pl. 14, fig. 14.
1867. *Stropheodonta demissa* Hall, Pal. N. Y., vol. 4, pp. 81, 101, pl. 11, figs. 14-17; pl. 12, figs. 1-5; pl. 17, figs. 2a-2s.
1897. *Stropheodonta demissa* Schuchert, Bull. U. S. Geol. Surv., No. 87, p. 421.
1913. *Stropheodonta demissa* Prosser, Md. Geol. Surv., Middle and Upper Devonian, p. 136, pl. 10, fig. 1; and Clarke and Swartz, p. 551, pl. 47, fig. 14.

This species is represented by numerous well-preserved specimens which are typical of the species as known elsewhere and are always easy

[1]Prosser, C. S., Md. Geol. Surv., Middle and Upper Devonian, p. 131.

to recognize. The concavo-convex shell, approximate parallelism of the lateral margins, and the strong plications in the umbonal region of the valves are the distinguishing features of the species. Two individuals of average size measure, length 29 mm., width 34 mm.; length 30 mm., width 35 mm. A larger example measures 33 mm. in length and 40 mm. in width.

Mature specimens are in general larger than the Columbus limestone representatives of the species, but seem to be identical with those from the Hamilton figured in the New York reports.

Stropheodonta (Leptostrophia) perplana (Conrad)

Plate III, fig. 11

1842. *Strophomena perplana* Conrad, Jour. Acad. Nat. Sci. Phila., vol. 8, p. 257, pl. 14, fig. 11.
1867. *Stropheodonta perplana* Hall, Pal. N. Y. vol. 4, pp. 92, 98-101, pl. 11, fig. 22; pl. 12, figs. 13-15; pl. 17, fig. 1.
1892. *Stropheodonta (Leptostrophia) perplana*, Hall and Clarke, Pal. N. Y. vol. 8, pt. 1, p. 288, pl. 15, figs. 2-13.
1911. *Stropheodonta perplana* Cleland, Wis. Geol. Nat. Hist. Surv., Bull. 21, p. 89, pl. 18, figs. 1-4.

Specimens belonging to this species are rare in the shale and only a few have been collected. The largest specimen studied measures approximately length 42 mm., width 50 mm.; smaller specimens however are more common. The hinge line is less than the greatest width which is slightly anterior to the middle; cardinal extremities somewhat mucronate; beaks scarcely defined. The surface is marked by closely-spaced, fine, subequal, radiating striae, frequently undulating, and increasing both by intercalation and bifurcation; these are crossed by fine, crowded, transverse lines which give the radiating striae a notched appearance. In some places the striae are considerably distorted, probably the result of some injury. Where the shell is broken or worn the pustulose character of the interior can be seen. The shell substance is extremely thin and delicate and in some specimens is replaced by pyrite. This species can easily be distinguished from the preceding one by the flatness of the shell and the exceptionally fine surface markings.

Genus *Pholidostrophia* Hall and Clarke

Pholidostrophia iowaensis (Owen)

Plate III, fig. 12

1852. *Chonetes* (?) *iowaensis* Owen, Geol. Surv. Wisconsin, Iowa, Minnesota, p. 584, pl. 3a, fig. 7.
1867. *Stropheodonta nacra* Hall, Pal. N. Y., vol. 4, pt. 1, p. 104, pl. 18, fig. 1.
1897. *Pholidostrophia iowaensis* Schuchert, U. S. G. S. Bull. 87, p. 308.

Description.—Shell small, semicircular, concavo-convex dorso-ventrally; hinge line crenulated (?), slightly less than the greatest width of the shell which is near the middle, and terminating in obtuse angles. The dimensions of an almost complete specimen are length 13 mm., width 17 mm., length of hinge 15 mm.

Pedicle valve moderately convex, being greatest in the umbonal region and flattening towards the margins; beak minute, scarcely elevated above the hinge; area narrow, without foramen, common to both valves. Brachial valve regularly concave, fitting into the curvature of the opposite valve. Beak scarcely defined. Shell substance thin and delicate; surface lustrous with faint growth lines evident on both valves.

The specimens available do not show the internal characters. They are discussed by Hall as follows. "The muscular impressions in the ventral valve extend more than half the length of the shell. The divaricator muscular imprints are deeply depressed, elongate-ovate, narrowing above and somewhat widely separated below; while the occlusor impressions are narrow-ovate spots on the thickened portion of the shell, and below these extends a narrow elevated band separating the other impressions. In the dorsal valve the anterior and posterior occlusor muscular impressions are small and not strongly defined. The cardinal process is slender, bifurcating, with a narrow rounded ridge extending from its base down the middle of the valve. The interior of the shell, excepting the muscular impressions, is studded with prominent scattered granules or papillae." Hall, 1867, reference above.

Remarks.—The writer has only two specimens of this species available for study. The crenulated hinge line and lustrous surface of the shell are the outstanding features of the species, and although the former is not distinctly shown on either of the specimens the identification is felt to be correct.

Genus *Chonetes* Fischer

Chonetes coronatus (Conrad)

Plate III, figs. 13-15

1842. *Strophomena carinata* Conrad, Jour. Acad. Nat. Sci., Phila., vol. 8, p. 257, pl. 14, fig. 13.
1857. *Chonetes coronata* Hall, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 146, figs. 1,2.
1867. *Chonetes coronata* Hall, Pal. N. Y. vol. 4, p. 133, pl. 21, figs. 9-12.
1897. *Chonetes coronatus* Schuchert, Bull. U. S. Geol. Surv., No. 87, p. 173.
1913. *Chonetes coronatus* Prosser, Md. Geol. Surv., Middle and Upper Devonian, p. 148, pl. 11, figs. 18-21.

Numerous specimens of varying sizes have been collected from the shale which agree in their essential characteristics with this typical Hamilton species. The specimens are almost always well preserved,

the shell material commonly having been replaced by pyrite. There is a complete gradation in size from small, flat, immature forms to full-grown, robust individuals which often attain a width of 30 mm. The large specimens have slightly stronger striations than is usual in the species, but there is an evident conformity in all other respects. The shallow depression which is characteristic of the ventral valve has been observed on most of the specimens, and is especially well developed on mature specimens. In nearly all cases the slender, oblique cardinal spines have been broken off and are represented only by their bases. Their exact number cannot always be determined but they appear to vary in number from 5 to 7, the last two near the beak becoming indistinct.

This species can be readily recognized by the large size of the full-grown individuals, the pronounced convexity of the pedicle valve and the corresponding concavity of the brachial, and by the numerous well-defined striations which increase both by bifurcation and intercalation.

Chonetes fragilis n. sp.

Plate III, figs. 16-19

Description—Shell of medium size, subcircular to subelliptical in outline; wider than long, the greatest width commonly slightly anterior to the middle, but occasionally the hinge equals the greatest width of the shell. Cardinal extremities rounded or to a small degree auricular. Lateral margins on some specimens almost at right angles to the hinge posteriorly, and then curving regularly into the anterior margin; in other specimens the lateral margins round regularly from the cardinal extremities to the front. Shell substance thin. The dimensions of an individual of average size are length 13 mm., width 18 mm. A small specimen measures 8 mm. in length and 12 mm. in width.

Pedicle valve moderately convex, greatest convexity in the middle of the shell, flattening laterally and anteriorly, and even becoming slightly concave towards the cardinal ears; beak inconspicuous, flattened, not extending beyond the cardinal margin; cardinal area sloping steeply or in plane of valve, obtusely triangular. Delthyrium broadly triangular, apical part covered by a convex deltidium, lower part occupied by the cardinal process. Cardinal margins sloping gently from beak to extremities and bearing 7 to 8 oblique spines on each side of the beak, the two or three nearest the beak hardly discernible. Internal characteristics not observed.

Brachial valve moderately concave, generally following the curvature of the opposite valve, the greatest convexity near the middle, flattening a little towards the lateral and anterior margins. Cardinal

area linear, narrower than that of the opposite valve, and having at the center opposite the delthyrium of the pedicle valve a triangular space covered by a convex chilidium and occupied by a part of the cardinal process. Cardinal process four pronged at posterior extremity. Inner surface of shell strongly papillose. Other internal features not observed.

Surface of both valves marked by very fine, rounded, radiating striae, which are separated by rounded furrows, and increase both by bifurcation and insertion. In an average sized specimen where 20 striations occur at the beak, about 80 are present at the margin. Striae crossed by concentric growth lines which usually become lamellose.

Remarks.—This species is very abundant in the shale and is represented by specimens of decidedly variable size. Due to the fragile condition of the shell material it is difficult to collect and preserve specimens without crushing and breaking. The form is found associated with *Chonetes coronatus* from which it may be differentiated by the smaller size of the full-grown individuals, the less transverse shape, and the more numerous and finer striations in specimens of corresponding size. The young of the two species are difficult to distinguish because of the similarity in size and shape, and in the strength and number of the striations.

Cotypes No. 16,259, Geological Museum, Ohio State University.

Genus *Productella* Hall

Productella spinulicosta Hall

1857. *Productella spinulicosta* Hall, Tenth Rep. N. Y. State Cab.Nat. Hist., p. 173.

1867. *Productella spinulicosta* Hall, N. Y., Pal., vol. 4, p. 160, pl. 23, figs. 25-37.

Description.—One fragmentary pedicle valve has been referred to this species, agreeing well in size, convexity, and in the number and distribution of the spines. Hall describes the species as follows: "Shell broad, semi-elliptical or somewhat orbicular; hinge line generally a little less than the greatest width of the shell. Ventral valve varying in shells of different size, from moderately to extremely gibbous in the middle, with the beak strongly incurved. Dorsal valve moderately concave in its upper part, and becoming more concave or arcuate towards the front. Surface marked by fine, strong, concentric striae which are sometimes crowded and wrinkled on the body of the shell. There are several rows of interrupted ridges or spine bases which in entire specimens support slender spines. The ears are strongly wrinkled and support a row of four or five spines just below the hinge line." Hall, 1867, reference above.

Genus *Rhipidomella* Oehlert

Rhipidomella vanuxemi Hall

Plate III, fig. 20

1857. *Orthis vanuxemi* Hall, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 135, figs. 1-7.
1892. *Rhipidomella vanuxemi* Hall and Clarke, Pal. N. Y., vol. 8, pt. 1, p. 225, pl. 6, figs. 14, 15; pl. 6a, figs. 7, 8.
1913. *Rhipidomella vanuxemi* Prosser, Md. Geol. Surv., Middle and Upper Devonian, p. 165, pl. 13, figs. 26-29; and Clarke and Swartz, p. 572, pl. 52, figs. 7-13.

A number of good specimens of this species have been found, the larger ones of which equal the large proportions attained by some of the New York shells. An average specimen measures 18 mm. in height and 20 mm. in width. The generally compressed condition of the shell, the subcircular outline, almost flat pedicle valve, gently convex brachial valve, and the numerous striations covering the surface of both valves are the important characteristics of the species.

Genus *Schizophoria* King

Schizophoria striatula (Schlotheim)

Plate III, fig. 21

1813. *Anomia terebratulites striatulus* Schlotheim, Min. Taschenbuch, 8, pl. 1, fig. 6.
1865. *Orthis striatula* Davidson, Brit. Dev. Brach., Pal. Soc., p. 87, pl. 17, figs. 4-7.
1897. *Schizophoria striatula* Schuchert, Bull. U. S. Geol. Surv., No. 87, p. 375.
1913. *Schizophoria striatula* Prosser, Md. Geol. Surv., Middle and Upper Devonian, p. 170, pl. 14, figs. 13, 14; and Clarke and Swartz, p. 572, pl. 52, figs. 14-18; pl. 53, figs. 1, 10.

Two or three specimens have been found which are referable to this species. The shells are somewhat distorted, the most perfect one measuring approximately 26 mm. in height and 35 mm. in width. The hinge line is short and the cardinal area due to the crushed condition has not been observed. The pedicle valve is moderately convex, and the wide, shallow sinus, beginning a little above the middle and extending to the anterior margin, is a noticeable feature. The brachial valve is strongly convex. Beaks very strongly incurved. Entire surface of both valves marked by uniformly fine, even striae, and in addition wrinkled lines of growth are conspicuous near the anterior margin.

The specimens do not differ markedly from representatives of the species from other localities.

Schizophoria striatula var. parvum n. var.

Plate III, figs. 22, 23

Description.—Shell small, moderately bi-convex, wider than high,

transversely subelliptical in outline, anterior margin slightly truncate; hinge line straight, a little more than half the width of the shell; cardinal extremities rounded; area broadly triangular, a little curved, striated vertically and at intervals longitudinally; delthyrium triangular, reaching to the apex of the pedicle beak. The dimensions of a complete specimen are length 15 mm., width 18 mm., the maximum width a little below the middle.

Pedicle valve convex on the umbo, flattening out towards the lateral and anterior margins, and near the latter developing a broad, ill-defined sinus; beak low and rounded, rising a little above the brachial beak. Brachial valve more regularly convex than pedicle and flattening much less prominently towards the margins; beak low and inconspicuous, slightly incurved.

Surface of both valves marked by closely-spaced, fine, rounded, radiating striae which increase by intercalation, and which are most irregular in size. Prominent growth rings occur at intervals.

Remarks.—The only specimens at hand are one or two complete individuals and some fragments. As a variety it seems well defined and can be distinguished from *Schizophoria striatula* by its smaller size, absence of well-defined sinus in the pedicle valve, and by the irregularity in the size of the striae. The possibility of the specimens representing the young of *Schizophoria striatula* is remote. It is possible that the form may ultimately prove to be a new species, but since its representation in the fauna is so meager, it seems best to reserve such consideration until additional specimens can be obtained.

Holotype and *Paratype* No. 16,261, Geological Museum, Ohio State University.

Order *Telotremata*

Genus *Camarotoechia* Hall and Clarke

Camarotoechia prolifica Hall (?)

Plate III, fig. 24

1867. *Rhynchonella (Stenocisma) prolifica* Hall, Pal. N. Y., vol. 4, p. 343, pl. 54A, figs. 1-10.

One crushed specimen has been observed which has been identified as this species. The shell is subtriangular or quadrangular in outline, the length being somewhat greater than the width. The dimensions are length 10 mm., width 9 mm. The plications are more numerous than is common to the species, 36 being present where generally 20 to 24 occur, three of which are in the sinus and 4 on the fold. The specimen may represent a distinct species but until more and better material is found it seems best to place it with this species.

Genus *Leiorhynchus* Hall

Leiorhynchus lucasi n. sp.

Plate III, figs. 25, 26

Description.—Shell small; biconvex; ovoid to subquadrangular in outline; length and width almost equal, the greatest width being below the middle; sides diverging gradually for over half the length and then curving abruptly to the front. The dimensions of a fairly complete specimen are length 18 mm., width 17 mm.

Pedicle valve moderately convex on the umbo, flattening laterally, and medially becoming depressed into a sinus, which is well marked anterior to the middle and becomes quite mucronate in front. Beak small, acute, pierced by a foramen. Brachial valve much deeper than the pedicle valve, curving gently from the umbo to the lateral slopes, and about the middle elevated into a broad, low fold which becomes more conspicuous near the anterior margin. Beak incurved below that of the opposite valve. Where the shell substance is worn away the cast of the interior reveals a narrow median septum extending from the beak for about one-fourth the length of the shell. No other internal characters have been observed.

Each valve marked by about 14, rounded, radiating plications, five of which are in the sinus, and apparently six elevated on the fold. The plications are simple except those on the fold and sinus which apparently bifurcate. In general the plications are fairly well marked over the umbo of the valves, but laterally soon become obsolete. At intervals the valves are concentrically marked by growth rings.

Remarks.—Only one specimen, the holotype, has been observed by the writer, and it has been referred rather confidently to a new species. The specimen is complete except for a portion of the anterior margin, and is mostly replaced by pyrite. There is an evident relationship with other species of the genus occurring in the Middle Devonian elsewhere. In general outline the specimen resembles some of those figured of *Leiorhynchus kelloggi* from New York, but has fewer plications than that species and they are developed much closer to the beak. From *Leiorhynchus dubius* it differs in its greater convexity and less clearly defined plications.

Holotype No. 16,260, Geological Museum, Ohio State University.

Genus *Atrypa* Dalman

Atrypa reticularis (Linnaeus)

Plate IV, fig. 1

1767. *Anomia reticularis* Linnaeus, Systema Naturae, ed. 12, vol. 1, p. 1,132.
1858. *Atrypa reticularis* Hall, Geol. Surv. Iowa, vol. 2, p. 515.

1867. *Atrypa reticularis* Hall, Pal. N. Y. vol. 4, pp. 316-321, pl. 52, figs. 1-3, 7-12; pl. 53, figs. 3-19; pl. 53a, figs. 22, 23.
1897. *Atrypa reticularis* Schuchert, U. S. Geol. Surv. 87, pp. 154, 155.
1913. *Atrypa reticularis* Prosser, Md. Geol. Surv., Middle and Upper Devonian, pp. 183-185, pl. 16, figs. 4-6; and Clarke and Swartz, pp. 586, 587, pl. 55, figs. 6-11.

This common and widely distributed Silurian and Devonian brachiopod is relatively abundant in the shale. The shells are strongly plicate, and the concentric growth lines marked by the upturning of the shelly spines are a conspicuous feature of well preserved specimens. In this latter respect some specimens suggest *Atrypa spinosa* but the concentric lamellae are never developed to such a conspicuous degree nor are the ribs so coarse as in that species. All our specimens are remarkably uniform in their characteristics. They occur in the form of casts, the shell commonly having been replaced by pyrite.

The specimens are in general large and robust, the mature ones often quite gibbous. An individual of average size measures length 35 mm., width 34 mm. The largest specimen studied measures 40 mm. in length and 40 mm. in width.

No marked difference has been noticed between the Ohio specimens and those occurring at a similar horizon in New York and elsewhere.

Genus *Cyrtina* Davidson

Cyrtina hamiltonensis Hall

Plate III, figs. 27, 28

1867. *Cyrtina hamiltonensis* Hall, Pal. N. Y. vol. 4, p. 268, pl. 27, figs. 1-4; pl. 44, figs. 26-33, 38-52.
1913. *Cyrtina hamiltonensis* Prosser, Md. Geol. Surv., Middle and Upper Devonian, p. 185, pl. 17, figs. 1-9.

This common and characteristic fossil of wide distribution throughout the Middle Devonian rocks of the United States is represented in our collections by only three or four specimens which are, however, entirely typical of the species. The largest of these measures length 14 mm., width 14 mm., height of cardinal area 6 mm. The distinctive features of the species are triangular subpyramidal form; high triangular cardinal area striated in both directions and with a long, narrow delthyrium closed by a convex pseudo-deltidium which is perforated below the apex by an elongate foramen; highly convex pedicle valve with pronounced median sinus and small number of plications (6-8) on each side; slightly convex to almost flat brachial valve having a flattened fold with sometimes a slight groove along its center, and with plications corresponding to those on the opposite valve; granulose surface markings and punctate shell structure.

Genus *Spirifer* Sowerby

Spirifer audaculus (Conrad)

Plate IV, figs. 2, 3

1842. *Delthyris audacula* Conrad, Jour. Acad. Nat. Sci., Phila., vol. 8, p. 262.
1867. *Spirifera medialis* Hall, Pal. N. Y., vol. 4, p. 227, pl. 38, figs. 1-25.
1893. *Spirifer audaculus* Hall and Clarke, Pal. N. Y., vol. 8, pt. 2, pp. 29-31, 39, pl 24, figs. 1-13; pl. 29, fig. 5.
1897. *Spirifer audaculus* Schuchert, U. S. Geol. Surv., Bull. 87, p. 382.
1913. *Spirifer audaculus* Prosser, Md. Geol. Surv., Middle and Upper Devonian, p. 192, pl. 18, figs. 7-9.

Hall's description in part.—"Shell subtriangular, semicircular or subelliptical; valves moderately convex in young specimens, becoming ventricose in old shells; hinge line usually extended beyond the width of the shell below, sometimes mucronate at the extremities; surface plicate.

"Ventral valve usually deeper than the dorsal; beak prominent, more or less incurved. Area generally of more than medium height, longitudinally striate and divided in the middle by the deltoid fissure which is twice as high as wide, and reaches to near the apex of the valve. Mesial sinus of moderate width, reaching to the apex, rather deep, generally rounded at the bottom but sometimes a little flattened; the margins subangular and distinct.

"Dorsal valve moderately convex or gibbous, the greatest convexity above the middle; beak small and slightly incurved. Area linear and well defined; the lateral extremities of the valve a little deflected along the hinge line. Mesial fold prominent, rising abruptly at the sides, rounded or slightly flattened at the top.

"Surface marked by from 20 to 30 simple plications on each side of the mesial fold and sinus. These are of medium size in full-grown shells, being either low rounded, flattened, sharply rounded, or subangular in different individuals, the principal ones are frequently marked along the center by a fine thread-like groove, a feature most common on the ventral valve. Numerous strong, concentric lines of growth mark the surface, and are very closely arranged near the front in full-grown specimens, giving a strongly imbricate character to that part of the shell." Hall, 1867, reference above.

Remarks.—This brachiopod is represented by numerous excellent specimens. In general shape, character of fold, sinus, and cardinal area there seems to be no marked departure from the New York specimens. There is, however, a slight difference in the number of plications. In the description quoted above the plications are said to vary from 20 to 30, but in the Ohio specimens the range is commonly from 21 to

28, while in small specimens there are as few as 16. Prosser[1] reports that some New York examples have only 18 well-defined plications, so it would seem that there is considerable range in the number of plications.

An additional interesting feature is that on the fold and sinus and to a slight extent on the lateral slopes are minute granules or pustules evidently resulting from extremely fine radiating striations, which are closely and evenly cancelled by growth lines. This character although common in *Spirifer marcyi* and allied forms is not generally considered typical of *Spirifer audaculus*. It seems to the writer, however, that these delicate markings might well have characterized the original shell material, and are only retained under the most favorable conditions of preservation, while in the majority of cases conditions are not favorable and so they are obliterated. It seems best after careful study to identify our form with this species.

Spirifer bownockeri n. sp.

Plate IV, figs. 4-6

Description.—Shell large, robust, broadly oval in outline; width greater than length although the relation of the width to the length is variable; greatest width of shell a little below the middle; hinge line intermediate in length; cardinal extremities obtusely angular, distinctly auricular in well-preserved specimens. The dimensions of a large individual are width 65 mm., length 42 mm., thickness 35 mm. A smaller specimen measures length 42 mm., width 55 mm., thickness 35 mm.

Pedicle valve moderately convex, greatest convexity anterior to or at the middle; beak obtuse, slightly incurved, scarcely elevated above the brachial beak; cardinal area well defined, narrow, gently sloping to almost perpendicular; delthyrium broadly triangular; lateral slopes strongly convex, flattening appreciably towards the cardinal ears; slopes marked with 15 to 20 plications, the first 6 of which near the sinus bifurcate each successively farther from the beak, so that in mature specimens this division appears to have taken place closer to the beak. The plications decrease in size towards the cardinal extremities, the last one or two sometimes becoming obsolete. Sinus without plications, deep, trough-like, increasing rapidly in width from beak to anterior margin, the latter extended into a conspicuous, triangular extension which fits into the fold of the opposite valve.

Brachial valve strongly convex, the greatest convexity about the middle of the shell, flattening towards the margins; plications similar to

[1]Prosser, C. S., Md. Geol. Surv., Middle and Upper Devonian, p. 193.

those of the pedicle valve; mesial fold prominent, acute, rapidly increasing in width from beak to anterior margin.

Entire surface of both valves marked by minute granules, regularly and evenly arranged in concentric rows, especially prominent on the fold and sinus and toward the anterior margin of the shell. The granules are probably formed by the transection of fine, radiating striae by growth lines, the striae being sometimes faintly preserved. This accounts for their crowded condition towards the front of the shell.

No internal characters have been observed.

Remarks.—This interesting species is represented by numerous excellent specimens. They are usually in the form of casts, the shell having been replaced by iron pyrite, and the visceral cavity filled with rock material. The form appears to be intermediate between *Spirifer acuminatus* and *Spirifer granulosus*. With the former it is very closely allied having a similar contour, prominent acute fold and sinus, and strongly plicated surface. It differs in the following respects: the fold is rather more acute and broadens anteriorly less rapidly; the sinus is deeper, more conspicuously v-shaped and slightly narrower; 6 plications bifurcate instead of 4 or 5; the shell is usually more transverse especially in mature specimens; the presence of minute granules over the entire surface which are almost always well preserved. This last characteristic is of outstanding importance. A few specimens of *Spirifer acuminatus* from the Columbus limestone which have been observed have a slightly granulose surface but the granules are never developed to anything approaching the remarkable degree exhibited in this species.

Spirifer bownockeri resembles *Spirifer granulosus* in the granulose surface but in that species the granules are large and arranged irregularly over the surface, while in *Spirifer bownockeri* they are smaller and arranged in definite rows. In other obvious ways the two species are dissimilar.

The acute fold and angular sinus, strongly plicate surface, and minutely granulose character of the shell are the outstanding characters of the species.

The species is named in honor of Professor J. A. Bownocker, State Geologist and Chairman of the Department of Geology, Ohio State University.

Cotypes No. 16,263, Geological Museum, Ohio State University.

Spirifer euryteines Owen

Plate IV, figs. 7, 8

1844. *Delthyris euriteines* Owen, Rep. Geol. Expl. Iowa, Wis., and Ill., p. 69, pl. 12, fig. 9.

1852. *Spirifer euriteines* Owen, Geol. Surv. Wis., Iowa, and Minn., p. 586, pl. 3, figs. 2-6.

1894. *Spirifer parryanus* Hall and Clarke, Pal. N. Y., vol. 8, pt. 2, pp. 29, 31, 39, pl. 22, figs. 8, 9, 15-17.
1897. *Spirifer eurytcines* Schuchert, Bull. U. S. Geol. Surv., 87, p. 389.

Description.—Shell of medium size, transversely elongate, greatest width along the hinge line; sides strongly curved; cardinal extremities obtuse to mucronate. The shells vary greatly in form and proportions. The dimensions of two specimens are length 35 mm., approximate width 60 mm.; length 33 mm., width 45 mm.

Pedicle valve quadrangular in outline, regularly arched from beak to margins, slightly flattened near the cardinal extremities; beak small, a little incurved and usually extending considerably above the hinge; area wide, flat to gently curved, striated vertically and to a lesser extent longitudinally; delthyrium a large triangular opening reaching to the apex of the beak. Sinus distinct, moderately deep, enlarging rapidly from beak to anterior margin, the latter being somewhat attenuate, rounded, and fitting into the fold of the opposite valve.

Brachial valve about equally convex with the pedicle, semi-circular to subelliptical in outline; fold expanding rapidly, shallow sinus commonly present throughout its extent, anterior margin truncate. Occasionally the sinus in the fold is absent and instead there is a conspicuous flattening on the top of the fold. Area vertical, narrow and linear; beak small, blunt, lower than pedicle beak.

Surface plicate, marked by about 20 simple, rounded ribs on each side of the fold and sinus, the last two or three near the cardinal ears often faint and obscure. Entire surface of both valves covered with radiating striae which frequently appear as elongate pustules where interfered with by growth lines. This pustulose character of the striae is particularly noticeable on the fold and sinus. Where the growth lines are crowded the striae appear as radial rows of minute granules.

Remarks.—This brachiopod occurs in less profusion than some of the other *Spirifers*. The shells are often distorted by crushing and fracturing and commonly not in such excellent condition of preservation as are examples of other species of the genus. The fine radial surface markings are the distinguishing marks of the species. The brachial valve of our form seems to be more convex than is common in the species, but otherwise there are no outstanding differences. From the associated species *Spirifer audaculus* it is readily distinguished by the larger size of the full-grown specimens, more extended hinge, larger plications, and different surface sculpture.

Spirifer mucronatus var. prolificum n. var.

Plate IV, figs. 9-14

Description.—This well-known species of the Hamilton is repre-

sented here by specimens that require a new variety. Shell transverse, of medium size; mature specimens medium to strongly convex; hinge line equal to greatest width of the shell; cardinal ears acute or rounded, or sometimes prolonged into mucronate points giving the hinge a length much greater than the width of the shell. Valves strongly plicate.

Pedicle valve moderately convex; sides sloping gently and more or less uniformly to the margins; sinus broad and deep, flattened in the bottom or occasionally rounded, outlined on either side by a strong plication, well defined to the beak; beak pointed, slightly incurved over the area; area triangular, of moderate height, longitudinally striate, center with a narrow triangular delthyrium. Brachial valve almost equally convex with the pedicle; mesial fold very high, commonly with a shallow sinus along the center. This last character is variable and all gradations from a mere flattening of the fold to a well-defined sinus are represented. Beak small, scarcely incurved; cardinal area narrow, longitudinally striate.

Surface of both valves marked by from 9 to 15 simple angular plications on either side of the fold and sinus, the outer ones of which begin along the cardinal margins. Numerous fine transverse growth lines are directed sharply anteriorly as they cross the plications giving the surface of the shell a serrate appearance. These become crowded and lamellose towards the front.

Interiors of pedicle valves reveal the short, somewhat blunt teeth with prominent and strongly diverging dental plates, and conspicuously striated muscular area.

Remarks.—The species is abundant and many specimens have been examined. They exhibit such a marked range in their characteristics that it has been difficult to arrive at satisfactory conclusions regarding the varietal features of the normal adult. Although the form strongly simulates *Spirifer mucronatus thedfordensis* certain differences exist which seem to the writer sufficient for considering this form a new variety. This conclusion has been reached after careful examination of many individuals in a representative collection. The main point of departure is that in *Spirifer mucronatus thedfordensis* an incipient fold in the sinus may be present in the early stages of growth but never in the later, whereas in the form under discussion the fold apparently is not present at any time, or very rarely, showing it to be a type farther advanced in its phyllogenetic history than the former, and distinctly in advance of the primitive *Spirifer mucronatus* where the fold may be present in the adult stage. Another fairly consistent difference is that the adult of our variety commonly retains the sinus in the fold, while the retention of this feature in the grown examples of *Spirifer mucronatus thedfordensis* is not a normal development although cases do occur. In this respect then our form shows less progression than that species. Where this secondary sinus becomes obsolete in our variety the fold

becomes flattened, rarely rounded. An average representative grown specimen is thick-set with only slightly extended hinge, a faint sinus in the fold of the brachial valve, rounded or flat sinus in pedicle valve, and 11 to 13 plications on either side of the fold and sinus. Attenuate and mucronate specimens also occur but not nearly in such abundance. In attenuate specimens as many as 15 plications have been recognized on either side of the fold and sinus, and in young individuals as few as 7.

The dimensions of 4 specimens are as follows: young specimen, length 10 mm., width 18 mm.; normal adult, length 23 mm., width 35 mm.; attenuate specimen length 19 mm., width 39 mm.; mucronate specimen, length 21 mm., width 50 mm.

This is an exceedingly abundant fossil in the shale and occurs in profusion in the lowest few inches, in places comprising almost the entire rock mass.

Cotypes No. 16,262, Geological Museum, Ohio State University.

Genus *Ambocoelia* Hall

Ambocoelia umbonata (Conrad)

1842. *Orthis umbonata* Conrad, Jour. Acad. Nat. Sci., Phila., vol. 8, p. 264, pl. 14, fig. 4.
1860. *Ambocoelia umbonata* Hall, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 71.
1867. *Ambocoelia umbonata* Hall, Pal. N. Y., vol. 4, p. 259, pl. 44, figs. 7-18.
1913. *Ambocoelia umbonata* Prosser, Md. Geol. Surv., Middle and Upper Devonian, p. 200, pl. 20, figs. 1, 2; and Clarke and Swartz, p. 602, pl. 59, figs. 3-7.

This little shell locally is abundant in the shale. The pedicle valves are most numerous, the brachial valves of rarer occurrence, and no case of the two valves in articulation has been observed. The specimens seem to conform closely with New York examples of the species and can be readily recognized because of the small size and the strongly convex pedicle valve with narrow sinus and high beak. Some specimens reveal in addition the large triangular delthyrium.

The dimensions of an average-sized individual are length 6 mm., width 8 mm. Numerous specimens are much smaller.

In contrast to most of the fauna this species is rather poorly preserved and as a rule the specimens are unsatisfactory for descriptive purposes. The fine radiating and concentric striae mentioned by Hall as characteristic of the species have not been observed.

Genus *Athyris* McCoy (emend. Hall and Clarke)

Athyris vittata Hall

Plate V, fig. 1

1867. *Athyris vittata* Hall, Pal. N. Y., vol. 4, p. 289, pl. 46, figs. 1-4.

Description.—Hall describes this species as follows: "Shell ovate-subquadrate, gibbous, with the mesial fold and sinus distinct; front conspicuously sinuate; hinge line short; cardinal extremities rounded. Ventral valve gibbous above, more convex than the dorsal; umbo prominent; the beak incurved and truncated in the plane of the longitudinal axis by a round foramen, curving very abruptly to the cardinal and cardino-lateral margins; the center marked by a well-defined mesial sinus which is continued nearly or quite to the beak and becoming much deeper and subangularly margined towards the front. Dorsal valve a little less gibbous than the ventral, sides regularly curving; the middle of the upper part distinctly prominent, and developed below in a strong mesial fold which is abruptly elevated in front. Surface marked by regularly imbricating lamellose lines of growth which on the better preserved surfaces are finely crenulate on their edges, and the intermediate spaces striate." Hall, 1867, reference above.

Remarks.—The one perfect specimen collected is in close agreement with Hall s description and figures of this species. The dimensions are length 16 mm., width 19 mm., thickness 10 mm. The form is notably convex and the fold and sinus are quite marked. That *Athyris vittata* is a distinct species and not a synonym of *Athyris fultonensis* is held by Branson[1] who makes comparisons and draws conclusions after examining hundreds of specimens of both species. In the opinion of the writer the distinction is valid.

Class *Pelecypoda*
Order *Prionodesmacea*
Genus *Grammysia* Vernieul

Grammysia bisulcata (Conrad)

Plate V, fig. 2

1838. *Pterinea bisulcata* Conrad, Geol. Surv. N. Y., Ann. Rep., p. 116.
1885. *Grammysia bisulcata* Hall, Pal. N. Y. vol. 5, pt. 1, Lamellibranchiata 2, p. 359, pl. 54, figs. 1-16; pl. 56, fig. 1; pl. 93, fig. 25.

Hall's description in part.—"Shell large, ovoid; length once and a half the height; basal margin broadly curved, with a constriction near the middle of its length; posterior margin abruptly rounded below and broadly curving or subtruncate above. Cardinal line nearly straight, more than half as long as the shell. Anterior end abruptly rounded below the deep lunule.

"Valves regularly convex below and gibbous or ventricose in the middle and above.

[1]Branson, E. B., 1923, Missouri Bur. Geol. and Mines, vol. 17, Second series, p. 109.

"Beaks sub-anterior, strong, incurved over the cardinal line. Umbo prominent, gibbous, with a cincture consisting of a strong fold with a furrow on each side, extending from the beak to the basal margin at about the middle of its length; this feature, alternating on the two sides, gives a sinuosity to the line of junction of the valves.

"Entire surface marked by fine concentric striae, which on some portions of the shell are aggregated into fascicles; and by strong, regular, persistent concentric ridges or folds, which are stronger upon the anterior part of the shell and distinctly undulated in crossing the cincture. The undulations occasionally become obsolete in the lower and posterior part of the shell, and sometimes are to be seen only on the anterior and umbonal portion. In well-preserved specimens the surface, especially in the umbonal region, is also marked by very fine, radiating, granulose striae which may be more or less interrupted by the concentric undulations." Hall, 1885, reference above.

Remarks.—A somewhat distorted cast of the interior retains the deeper surface markings of the shell so that identification with the above species is made with considerable assurance. The fold which traverses each valve obliquely from beak to anterior margin and the strong concentric undulations are prominent features. The dimensions are length 55 mm., height 35 mm.

Genus *Pterinea* Goldfuss

Pterinea flabellum (Conrad)

Plate V, fig. 3

1842. *Avicula flabella* Conrad, Jour. Acad. Sci., Phila., vol. 8, p. 238, pl. 12, fig. 8.
1884. *Pterinea flabella* Hall, Pal. N. Y. vol. 5, pl. 1, Lamellibranchiata 1, p. 93, pl. 14, figs. 1-21; pl. 15, figs. 1, 4-6, 8-10; pl. 83, figs. 11, 12.
1903. *Pterinea flabellum* Clarke, N. Y. State Mus., Bull. 65, p. 494.
1913. *Pterinea flabellum* Prosser and Kindle, Mid. and Upper Dev. Md., p. 250, pl. 29, figs. 1-4.

This characteristic Devonian species is represented in our collections by a number of separate valves. The specimens are generally exfoliated with only remnants of the shell adhering to the interior molds, the exfoliated portions of which show remarkably well the characteristic markings of the exterior of the shell. Prosser and Kindle discuss the species as follows: "Shell large; broad or narrow ovate, oblique, rarely erect; length from two-thirds to nearly equal the height. Left valve more or less convex, often gibbous or arcuate; right valve flat or concave, with a little convexity on the umbo; hinge line straight, extended on the posterior side, and length greater than that of the valve; beak of left valve near the anterior extremity of the hinge line and

curving forward over it; umbonal region gibbous; beak of right valve depressed and not rising above the hinge; wing large, triangular, nearly flat, margin concave and extremely acute; ear of left valve a simple rounded convex lobe. Test thick; left valve marked with from 6 to 12 strong rounded rays, which start near the beak and continue simple to the margin; the interspaces are marked by smaller, alternating costae; there are also strong, concentric, lamellose striae of growth; in the partially exfoliated condition, and in the casts, the ears show the concentric striae and the wings evidences of the rays." Prosser and Kindle, 1913, reference above.

The dimensions of an average specimen are length along hinge 35 mm., height about 30 mm.

Genus *Actinodesma* Sandb.

Actinodesma erectum (Conrad)

1842. *Aviculata erecta* Conrad, Jour. Acad. Nat. Sci., Phila., p. 238, pl. 12, fig. 5.
1884. *Glyptodesma erectum* Hall, Pal. N. Y. vol. 5, pt. 1, Lamellibranchiata 1, pp. 153-155, pl. 11, figs. 1-10; pl. 12, figs. 1-3, 5-9; pl. 13, figs. 1-4, 12-15; pl. 25, figs. 14-17; pl. 86, figs. 1-8; pl. 87, figs. 1-3.
1909. *Actinodesma erectum* Grabau and Shimer, North American Index Fossils, vol. I, p. 423, fig. 553 a, b.

A single fragmentary left valve is assigned to this species. The large triangular posterior wing, extended hinge, and the thick shell marked by concentric growth wrinkles are the outstanding features of the specimen, and in all these characters it conforms very well to the essential characters of the species.

Genus *Modiomorpha* Hall

Modiomorpha concentrica Hall

Plate V, fig. 4

1838. *Pterinea concentrica* Conrad, Geol. Surv. N. Y., Ann. Rept., p. 116.
1885. *Modiomorpha concentrica* Hall, Pal. N. Y., vol. 5, pt. 1, Lamellibranchiata 2, p. 275, pl. 34, figs. 9, 10; pl. 35, figs. 1-5; pl. 36, figs. 1-16 (17, 18?).
1913. *Modiomorpha concentrica* Prosser, Mid. and Upper Dev. Md., p. 266, pl. 32, figs. 5-9.

Hall's description.—"Shell of medium size, ovate, extremely variable in its proportions, length less than twice the height; basal margin often nearly straight, usually a little concave on the anterior third; posterior margin abruptly rounded below and more gently curving above; cardinal margins oblique in the prevailing forms, moderately arcuate, often nearly straight, sub-alate in many specimens. Anterior

end produced beyond the beaks, abruptly rounded, sometimes nasute, limited by a broad depression from the beak to about the anterior third of the basal margin.

"Valves moderately convex, gibbous along the umbonal slope; the point of greatest convexity is about the anterior third of the length of the shell. Hinge line extending half, or sometimes more than half the length of the shell. Beaks sub-anterior, small, sharply angular, appressed, directed forward. Umbonal region a prominent sub-angular elevation, extending obliquely from the beak toward the post-basal margin, usually dying out about the middle of the length of the shell. Test comparatively thick, strongly ornamented by regular, concentric, rounded, or sub-angular striae, which become lamellose and coalescing on the anterior end of the valves where they are less prominent.

"Anterior muscular impression strong, striated, situated just within the anterior margin, with a small retractor scar above it. Posterior impression large and shallow. Pallial line moderately impressed. Hinge furnished with a strong cardinal tooth, just posterior to the beak in the left valve, and a corresponding depression in the right valve. No proper lateral teeth have been observed, but the cardinal margin is thickened and grooved from the beak backward about half the length of the cardinal line." Hall, 1885, reference above.

Remarks.—The species is evidently of rare occurrence in the shale since only two imperfect specimens have so far been seen. They preserve, however, distinct characters of the species, and agree essentially with the New York examples figured by Hall. The diagnostic features are the more or less arcuate outline, anteriorly placed beaks, prominent oblique, umbonal ridges, and strong, regular, concentric striae.

The dimensions of the larger specimen are length approximately 40 mm., height 25 mm. The smaller specimen is figured.

Modiomorpha mytiloides (Conrad) (?)

Plate V, fig. 5

1841. *Cypricardites mytiloides* Conrad, Geol. Surv. N. Y., Fifth Ann. Rept., p. 52.
1885. *Modiomorpha mytiloides* Hall, Pal. N. Y. vol. 5, pt. 1, p. 277, pl. 37, fig. 3; pl. 38, figs. 1-16.

Description.—A single example is referred with some question to the above species, for on account of its small size it is difficult to decide whether it is a young individual belonging to this species or whether it is a mature individual belonging to an undescribed species. The dimensions of the specimen are length 12 mm., height 8 mm.

The valves are elongate, moderately convex, the basal margin nearly straight and curving regularly to the anterior and posterior ex-

tremities. The posterior margin appears to curve evenly from the base to the cardinal line but since a portion of the posterior hinge is missing the original line of the postero-cardinal margin cannot be accurately determined. Anterior end somewhat extended, curving uniformly. Character of hinge not shown. Beaks situated anteriorly about one-fourth the length of the shell from the anterior end. Both valves marked by concentric growth striae, of sub-equal size, which at more or less regular intervals are crowded and elevated into prominent ridges especially in the umbonal ridge and the antero-lateral slope.

Remarks.—The umbonal ridge is rather better defined than is common in the species, and the sinus mentioned by Hall[1], which extends from anterior to the beak to the middle of the shell, is lacking. Aside from these differences the specimen agrees very well with New York examples, but so far as present knowledge goes its position in the above species is questionable.

Class *Gastropoda*
Subclass *Streptoneura*
Order *Ctenobranchiata*
Genus *Platyceras* Conrad

Platyceras bucculentum Hall

Plate V, figs. 6, 7

1879. *Platyceras bucculentum* Hall, Pal. N. Y. vol. 5, pt. 2, p. 10, pl. 3, figs. 7, 26-29.

Hall's description.—"Shell ventricose, obliquely subovoid. Apex extremely attenuate, the spire making one or two closely enrolled volutions, with a gently enlarging diameter, and below this abruptly expanding and becoming very ventricose in the middle and lower part; spreading more upon the right side than upon the left; the shell near the posterior side swells out into a distinct pouch-like projection, with two or three rounded folds or semiplications, which give a deeply sinuous outline to the margin. Aperture subovate, and sinuate on the right posterior side. Peristome sinuous, and on the posterior side spreading partially over the preceding volution.

"Surface marked by fine, closely arranged concentric striae, which are undulated towards the margin of the aperture, and sometimes over the greater part of the surface, the irregularity having commenced during the earlier stages of growth. In well-preserved specimens there are revolving striae or fascicles, rising in little bands of obsolescent striae, giving a waved aspect to the surface." Hall, 1879, reference above.

Remarks.—A few specimens showing great variability in form are assigned to this species. It is well known that a wide range may exist

[1]Reference quoted in bibliography above.

in the shape and size of individuals within a species of the genus due to their habit of attaching themselves to crinoids and other organisms and thus modifying the shape of the aperture to fit the irregularities of the surface of the host. When this is taken into consideration it appears that all these specimens may belong to the same species. Some of the specimens are attached to crinoids and it is very clearly shown how the host is the controlling factor in producing a sinuous and irregular peristome. The specimens are referred to *Platyceras bucculentum* because of the ventricose shape of the shell, the minute apex, widely expanded body whorl, and the fine, closely-spaced, undulating, concentric striae. None of the specimens show the angular dorsum which characterizes the associated species *Platyceras carinatum.*

Platyceras carinatum Hall

Plate V, figs. 8, 9

1879. *Platyceras carinatum* Hall, Pal. N. Y., vol. 5, pt. 2, p. 5, pl. 2, figs. 12-29.

Hall's description.—"Shell obliquely subconical or subpyramidal; the nucleus or apex minute and making from one to one and a half volutions which are vertically compressed, and below which the body volution is abruptly expanded; the dorsum angular or marked by an angular carina, which often becomes double in old shells, or is rounded on the summit. This angularity or carina indicates by the direction of the striae the existence of a sinus in the peristome from an early period of growth; and sometimes there may have been two sinuosities close together giving the double carina. There is usually a depression along one or both sides of the carina with longitudinal folds (obscure plications) on one or both sides which become more strongly developed towards the aperture and are very conspicuous in old shells; the right side is more expanded than the left and in some well-preserved specimens is nearly twice as wide. Aperture very oblique, rhomboidal or subtriangular, and the peristome is sinuous.

"Surface marked by fine, closely arranged undulating striae of growth which are not lamellose." Hall, 1879, reference above.

Remarks.—The collections contain several specimens evidently belonging to the above species. In the general size and proportions, in the tightly coiled and compressed spire, and in the ventricose body volution, they are in close agreement with New York specimens figured by Hall. However the dorsal ridge is not so noticeably angular, and in most cases instead of persisting to the aperture flattens out partially or entirely before reaching the edge. The character of the aperture cannot be accurately determined because of the rock matrix but it is apparently rhomboidal in outline. Some specimens are compressed

vertically more than is common in the species, but since due allowance must be made for crushing it does not seem to the writer that this is sufficient reason for separation into another species.

Platyceras rarispinum Hall

Plate V, fig. 10

1879. *Platyceras rarispinum* Hall, Pal. N. Y. vol. 5, pt. 2, p. 16, pl. 5, figs. 5-7, 10.

Description.—Shell subpyramidal, arcuate, consisting of two volutions. Apex minute; spire tightly coiled for about one volution and slightly depressed below the plane of the body whorl; shell enlarging gradually at first, then expanding rapidly into the body volution which becomes markedly ventricose, is depressed on the dorsum, and marked on the right and left sides by somewhat obscure rounded folds which begin near the apex and extend to the margin of the aperture. The aperture is apparently oval with undulating peristome. Fine, closely-arranged, wavy, transverse lines which correspond to the sinuosities of the aperture mark the surface, and in addition there are a few scattered tubular spine bases distributed irregularly over the surface, six of which were counted on one specimen.

Remarks.—The only specimen of this species which has been found in the shale is distinctly more ventricose than the examples figured by Hall, and in addition an obscure fold marks the right side as well as the left. Additional material may justify the separation of our form into a distinct species, but at present it is thought advisable to place it in the above species.

Genus *Diaphorostoma* Fisher

Diaphorostoma lineatum (Conrad)

Plate V, fig. 11

1842. *Platyostoma lineata* Conrad, Jour. Acad. Nat. Sci., Phila., vol. 8, p. 276, pl. 17, fig. 7.

1879. *Platyostoma lineata* Hall, Pal. N. Y. vol. 5, pt. 2, p. 21, pl. 10, figs. 1-21.

1901. *Diaphorostoma lineatum* Clarke, N. Y. State Mus., Bull. 49, p. 131.

1913. *Diaphorostoma lineatum* Prosser, Md. Geol. Surv., Mid. and Upper Dev., p. 298, pl. 37, figs. 7-12; also *Diaphorostoma lineatum* Clarke and Swartz, p. 684, pl. 70, figs. 17-19.

One small specimen, evidently a young individual is the only representative of the species which has been collected from the shale at this date. The shell is subglobose, the spire elevated only slightly, and consists of 4 volutions, the outer one of which is the most ventri-

cose. The contour of the aperture cannot be determined owing to the rock filling but it appears to be suborbicular in outline. The reticulate surface markings which are so characteristic of the species are very well preserved, the revolving striae being a little wavy and crossed by rather finer concentric striae.

The dimensions of the specimen are height 9 mm., width 19 mm.

Suborder *Pteropoda*
Genus *Styliolina* Karpinsky

Styliolina fissurella (Hall)

Plate V, fig. 12

1843. *Tentaculites fissurella* Hall, Geol. of New York, Surv. Fourth Geolog. Dist., p. 180, figs. 9, 10; p. 222, fig. 4.
1879. *Styliola fissurella* Hall, Pal. N. Y. vol. 5, pt. 2, p. 178, pl. 31a., figs. 1-30.

Description.—Shell a minute, slender, elongate-conical tube having a length of from about 2 to 5 mm. Apical part of tube solid; apex minute, rarely bulbiform; enlarging gradually and more or less uniformly to the apertural end. Surface of some specimens smooth, while others show fine longitudinal striae extending almost the entire length of the shell. The fine growth lines, stated by Hall to be present in some specimens and unequally developed on different parts of the shell, have not been observed.

Remarks.—Apart from the apparent absence of the growth striae on all specimens they are indistinguishable from figured New York examples of this species.

Suborder *Conularida*
Genus *Tentaculites* Schlotheim

Tentaculites bellulus Hall (?)

Plate V, fig. 13

1879. *Tentaculites bellulus* Hall, Pal. N. Y. vol. 5, pt. 2, p. 169, pl. 31, figs. 15-18; pl. 31a, figs. 48-51.

Small specimens have been recognized which may represent the apical portions of individuals belonging to this species, but they are inadequate to permit positive identification. One specimen examined measures 2.5 mm. in length, is extremely attenuate, and has regular and closely arranged acute annulations, which near the apex become so low and crowded that they are not visible without the aid of a lens. The extreme apical portion is probably smooth. Near the apex 25 annulations are crowded into the space of 1 mm., while toward the

apertural end 12 occur in 1 mm. Another specimen 7 mm. long has the annulations more widely spaced, 7 occupying 1 mm. near the aperture, and near the apical end 12 occupy a similar space. No transverse striae could be detected.

Class *Cephalopoda*
Subclass *Tetrabranchiata*
Genus *Protokionoceras* Grabau and Shimer

Protokionoceras sp.

A few crushed fragments of a straight cephalopod have been observed which probably belong to this genus. In size of shell, depth of carinae, and excentric position of the siphuncle they are similar to *Protokionoceras marcellense* (Vanuxem), but the specimens are entirely too fragmentary to make specific identification possible. Two fragments have the greater part of the surface covered with *Reptaria stolonifera*, a small branching bryozoa.

PHYLUM ARTHROPODA

Class *Crustacea*
Subclass *Trilobita*
Genus *Phacops* Emmrich

Phacops rana var. milleri n. var.

Plate V, figs. 14-17

Description.—General form elongate, subelliptical, length equal to about twice the greatest width; cephalon semi-circular or arc-like; frontal portion of the glabella and the genal extremities slightly protruding, the latter broadly rounded; frontal margin concealed by the overhanging glabella; glabella large, gibbous, subpentagonal, widening rapidly anteriorly; transverse furrows 3, the anterior two rarely discernible, while the posterior one reaches across the entire width of the glabella: facial sutures not observed. Cheeks almost in a plane with the visual area, narrowing anteriorly and abruptly deflected ventrally to form the doublure.

Eyes large, schizochroal, hardly reaching the height of the glabella; palpebral lobe distinct, lower than the palpebrum and extending to the occipetal furrow; palpebrum crescentric; visual area separated from the cheek by a strong, smooth furrow; lenses abundant, from 80 to 130 for each eye.

Thorax subquadrate, the lateral margins gradually tapering to the pygidium; segments well defined, 11 to 12 in number. Axis convex, slightly narrower than pleural lobes, tapering posteriorly. Pleural

segments horizontal for about one-third their width from the axis, thence bent abruptly ventrally; each segment marked by a furrow which continues only to the fulcrum.

Pygidium semi-circular, easily distinguished from thorax; axis marked by 9 annulations which narrow posteriorly and terminate just within the posterior margin; pleurae broad, less convex than axis, usually with 7 annulations which are well defined for about two-thirds the distance to the margin, and then become entirely obsolete.

Entire surface of test more or less completely ornamented with numerous tubercles which are largest and most abundant upon the glabella.

Remarks.—Incomplete specimens of this variety are abundant in the shale and a number of perfect specimens have also been found. Considerable variation in size is exhibited, and all ages and stages of development seem to be represented in our collections.

An examination of typical specimens shows that they uniformly possess a greater number of corneal lenses in the eye than is common to the species *Phacops rana*. Hall[1] states that the average number of eye facets in the normal adult of *Phacops rana* is between 40 and 50 for each eye and that the variation lies between 30 and 88. He adds further that eyes showing more than 65 and less than 40 lenses are unusual. Of the numerous cephala of our variety which have been studied in no case was the number of lenses found to be less than 80, and the greatest number was 130. In four specimens chosen at random 107, 114, 116, and 120 lenses respectively were counted. Eyes showing more than 100 lenses are much more common than eyes showing less.

A second evident departure from the species is seen in the arrangement of the lenses in vertical rather than in diagonal rows. In normal adults 18 vertical rows are present in contrast to the 11 diagonal rows in normal adults of *Phacops rana*. In rare cases 16 rows occur. The scleral cavities moreover are distinctly shallower in most specimens so that the lenses stand out from the surface more conspicuously. These differences are considered sufficient basis for the establishment of a new variety for this form. In all other specific relationships no differences could be found.

The dimensions of a cotype are length of body 86 mm., length of cephalon 23 mm., width of cephalon 38 mm., length of thorax 45 mm., length of pygidium 18 mm. A smaller specimen measures length of cephalon 12 mm., width of cephalon 23 mm., length of thorax 27 mm., length of pygidium 8 mm. A large separate cephalon measures 17 mm. in length and 35 mm. in width.

[1]Hall, James, Pal. N. Y., 1888, vol. 7, p. 21.

The varietal name is given in honor of Mr. C. D. Miller of Sylvania, Ohio, who has accumulated an extremely fine collection of this trilobite. The Ohio State University is indebted to him for the finest specimens in its collection.

Cotypes No. 16,266, Geological Museum, Ohio State University.

Subclass *Eucrustacea*
Order *Ostracoda*
Genus *Cytherella* Jones

Cytherella (?) *bispinulatus* n. sp.

Plate V, figs. 18, 19

Description.—Carapace minute, prominently convex, elliptical to ovoid in outline, the proportional height and length being somewhat variable but are usually about as two to three. A typical specimen measures length 1.25 mm., height .50 mm. Vertical edge convex and projecting notably posteriorly; dorsal edge very slightly curved upward. Valves unequal, right larger than left and overlapping it except along the hinge. Anterior end rounded somewhat narrowly, and marked on each valve by an elongate and crescentric eye tubercle situated more or less parallel to the anterior margin. Posterior end more broadly rounded than the anterior, and having on each valve two small, delicate, subequal tubercles, which are the broken bases of short spines. These vary to some extent in size and relative position in different specimens. A smooth central spot is present in both valves. The entire surface is pitted, the pits being large and conspicuous near the center of the valves, but extremely minute near the edge, and often quite obsolete at the ends.

Remarks.—The generic relationships of this interesting little ostracod are not entirely clear and it has been placed in the above genus only provisionally. In the general contour of the shell, pitted surface, smooth central spot, and larger right valve, it resembles the genus *Cytherella*. It differs, however, in the apparent absence of the groove in the inner side of the right valve which is said to be the principal diagnostic feature of the genus, and in the presence of the two posterior tubercles. It is not unlikely that the specimens may eventually be placed in a new genus.

These tiny shells are scattered rather abundantly in places, the separate valves most commonly being found. The shell substance is delicate and brittle and much difficulty is experienced in getting the shells free from the rock without breaking.

Cotypes No. 16,265, Geological Museum, Ohio State University.

Blank Page

PLATE I

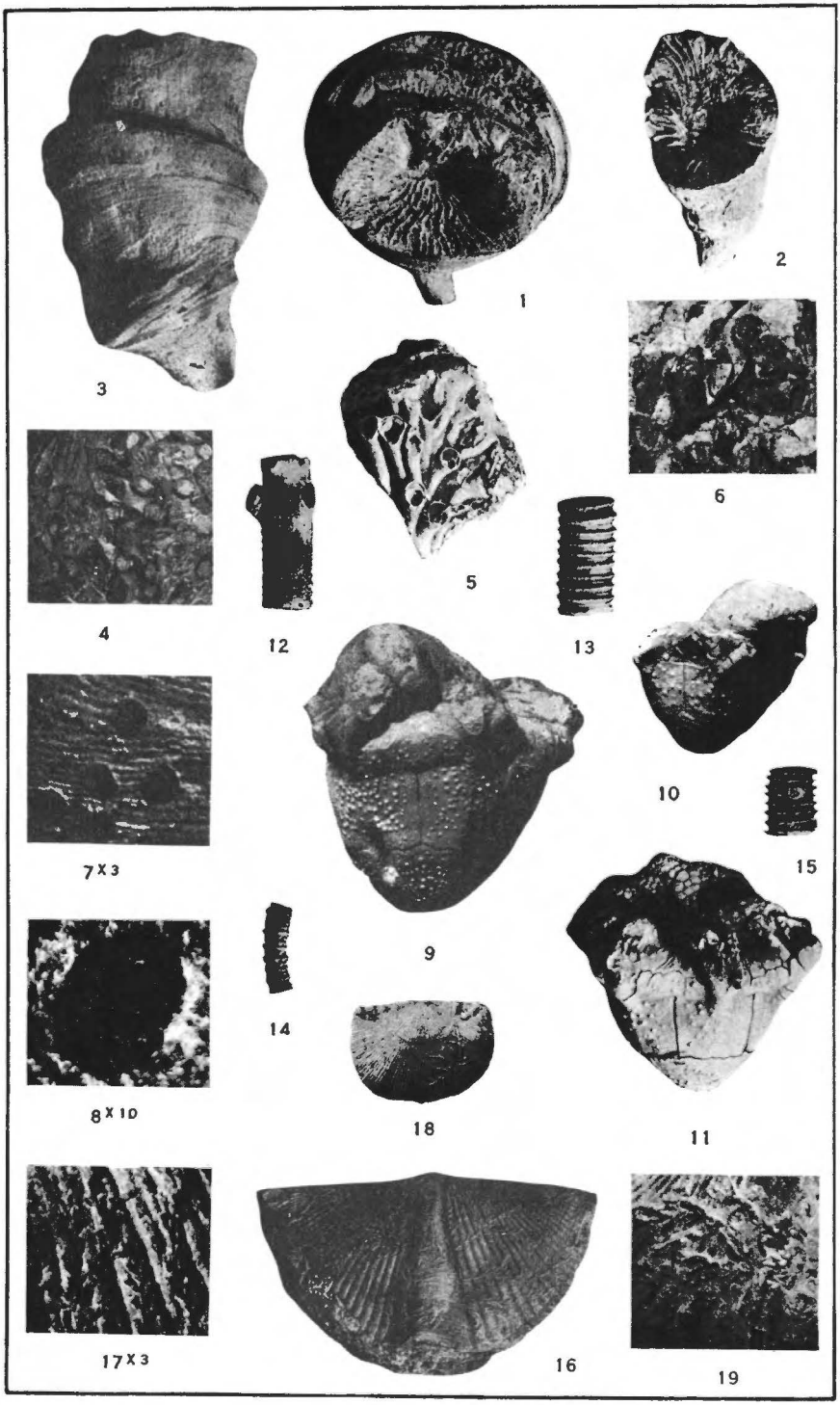
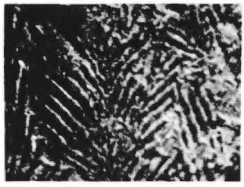
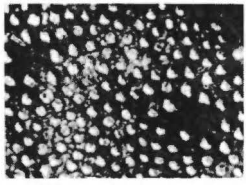

3
1
2
6
4
12
5
13
10
7X3
9
15
14
8X10
18
11
17X3
16
19

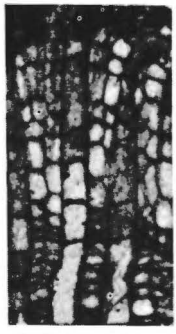
PLATE II



2 X 3

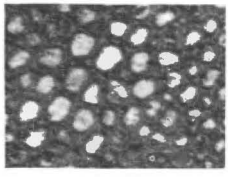


3 X 6

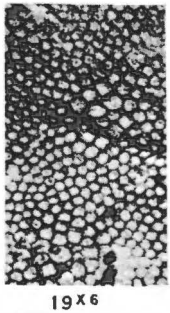


4 X 12

7

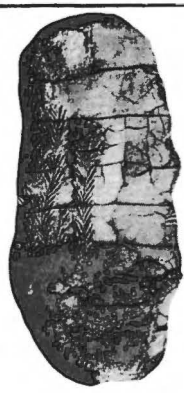


9 X 12



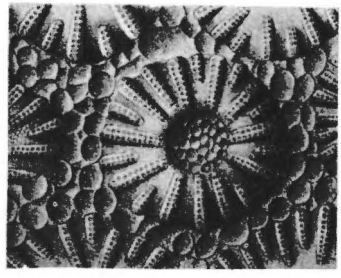
19 X 6

17



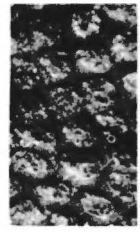
1

5

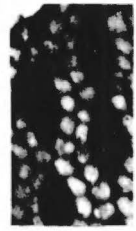


6 X 6

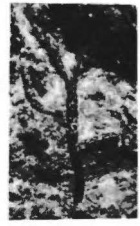
18 X 6



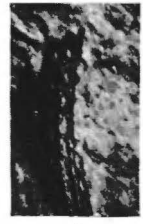
11 X 6



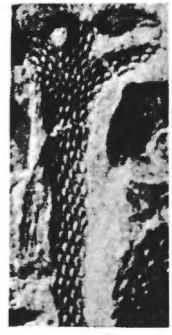
12 X 12



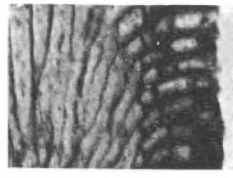
13 X 3



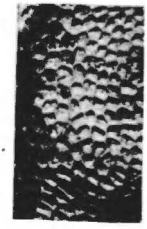
14 X 10



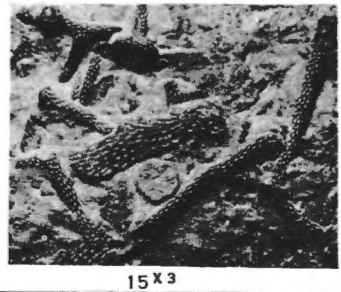
16 X 6



10 X 12



8 X 6



15 X 3

PLATE III

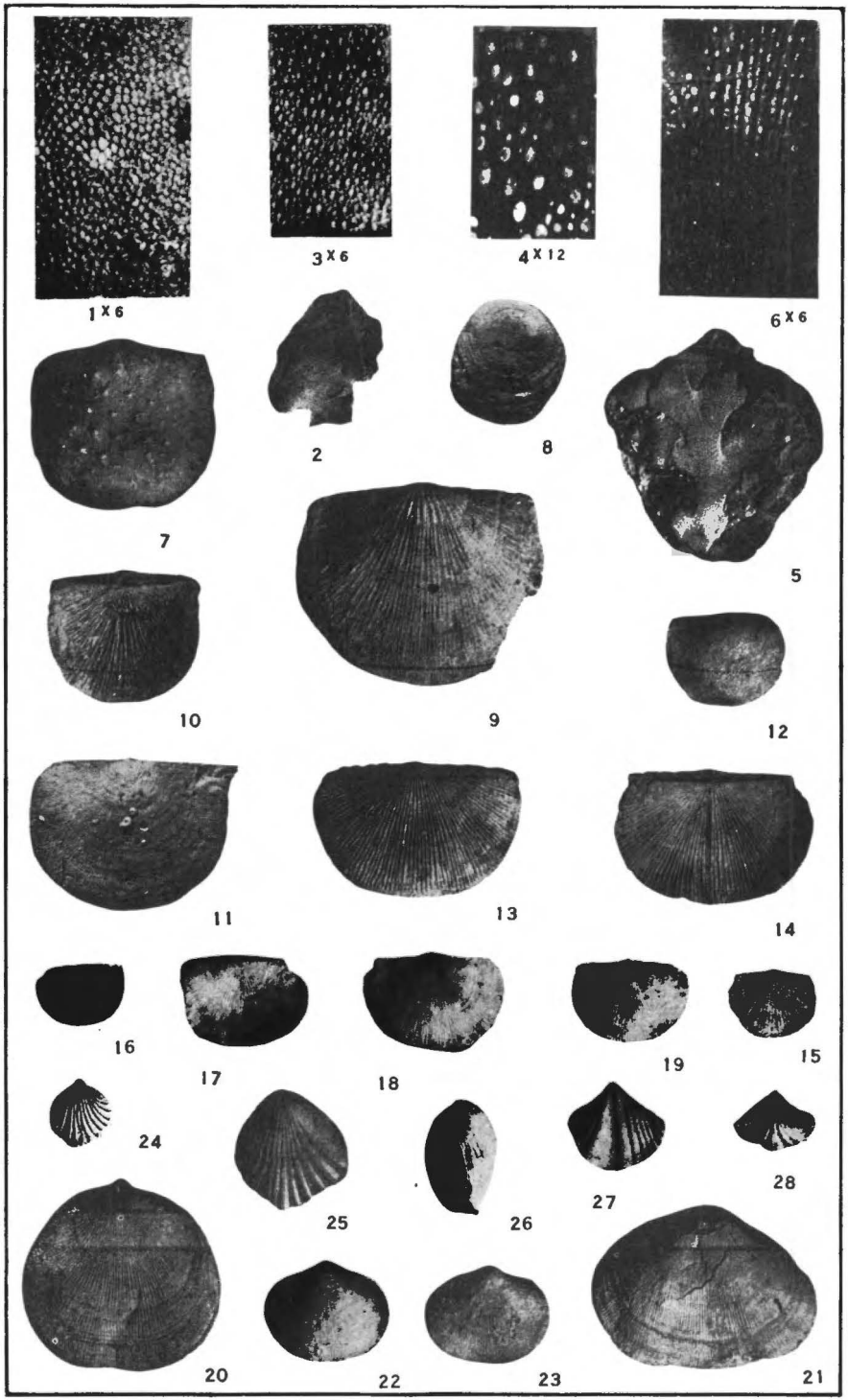

1 X 6
3 X 6
4 X 12
6 X 6
2
8
7
5
10
9
12
11
13
14
16
17
18
19
15
24
25
26
27
28
20
22
23
21

PLATE IV

Page

Fig. 1. *Atrypa reticularis* (Linnaeus)..... 42
Cardinal view.

Figs. 2, 3. *Spirifer audaculus* (Conrad)..... 44
Pedicle and cardinal views.

Figs. 4–6. *Spirifer bownockeri* n. sp..... 45
Fig. 4. Cardinal view.
Fig. 5. Brachial view showing prominent acute fold.
Fig. 6. Portion of surface enlarged. x6.

Figs. 7, 8. *Spirifer euryteines* Owen..... 46
Pedicle and brachial views of two different specimens.

Figs. 9–14. *Spirifer mucronatus* v. *prolificum* n. var..... 47
Figs. 9–11. Three brachial views showing variations in shape of shell.
Fig. 12. Cardinal view.
Fig. 13. Pedicle view of incomplete specimen with mucronate hinge.
Fig. 14. Brachial view of small specimen.

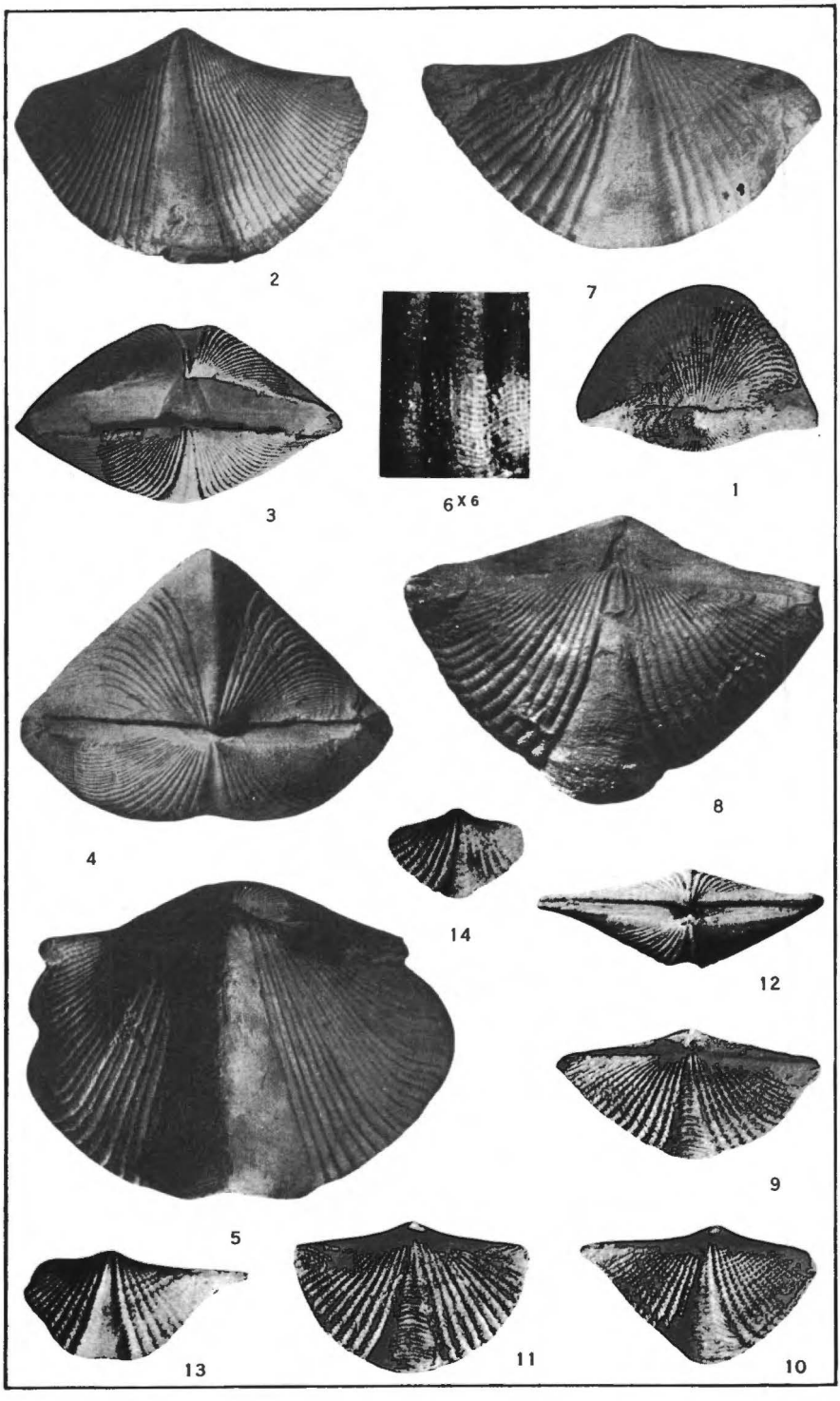
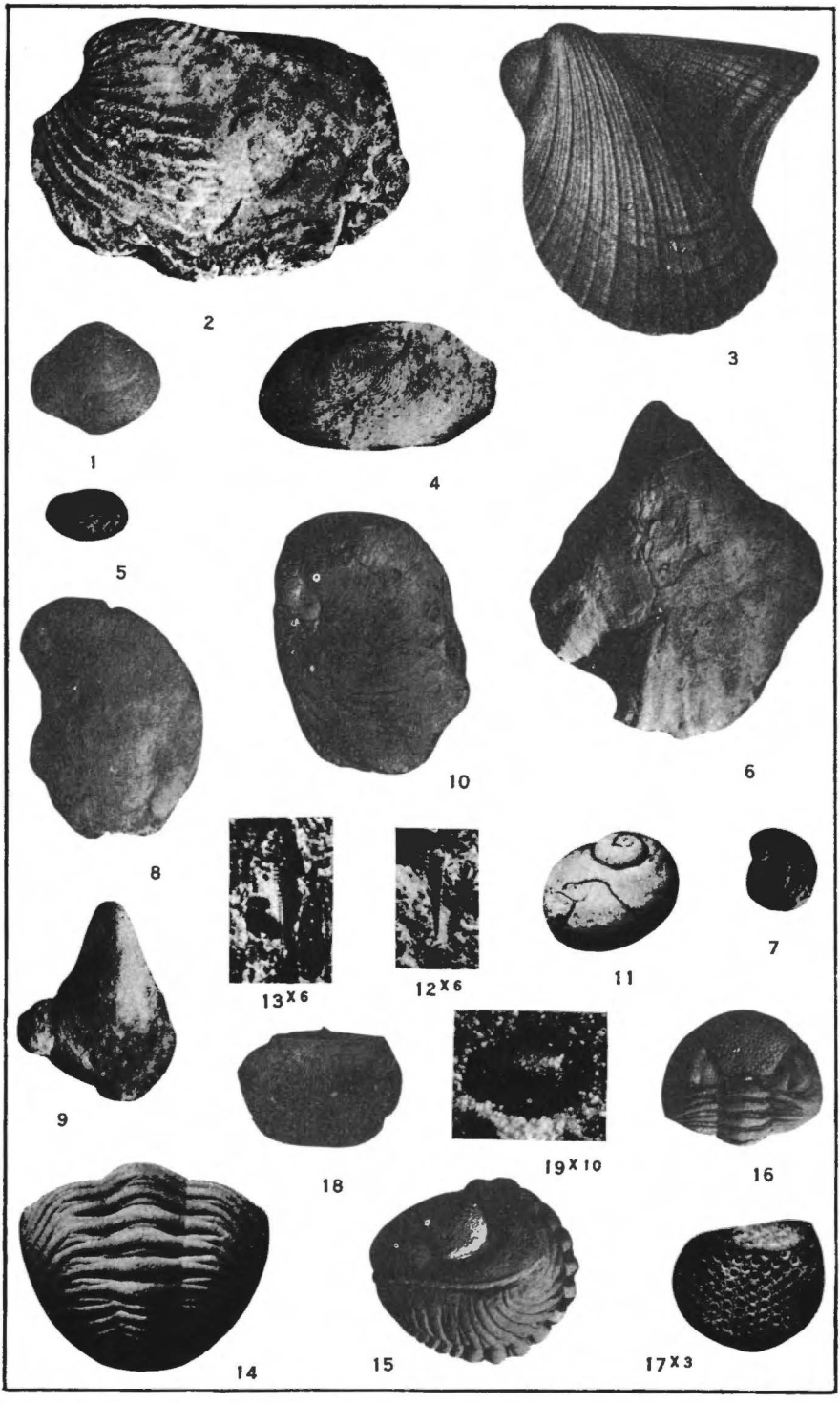

2
7
3
6 X 6
1
4
8
14
12
5
9
13
11
10

PLATE V


2
3
1
4
5
6
10
8
13X6
12X6
11
7
9
18
19X10
16
14
15
17X3

Blank Page

INDEX

O

P

R

S